November 25, 1957 75 cents

AVIATION WEEK

A McGRAW-HILL PUBLICATION

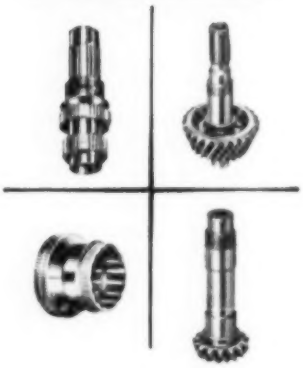
Special Report On Rocketdyne

•

Orpheus May Fill Wide Market Role

Douglas Thor

—but he's working for you



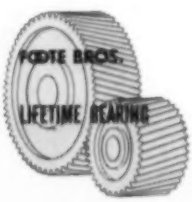
This man is hard to please. Nothing short of optimum accuracy and conformity to specifications satisfies him. We *like* it that way, and are glad we have many more people in the Inspection Departments here at Foote Bros. just like him.

Meticulous and exhaustive inspection is an important part of our production processes. It must be, because quantity production of precision gearing and actuating mechanisms for the aviation industry is our business.

It is men like these who work for you, and, in a very real sense, are the guardians of the Foote Bros. reputation for producing the finest components and assemblies of their type.

Another reason to come to Foote Bros. first, when it comes to aircraft power transmission, actuation, or gearing.

this trademark stands for the finest industrial gearing made



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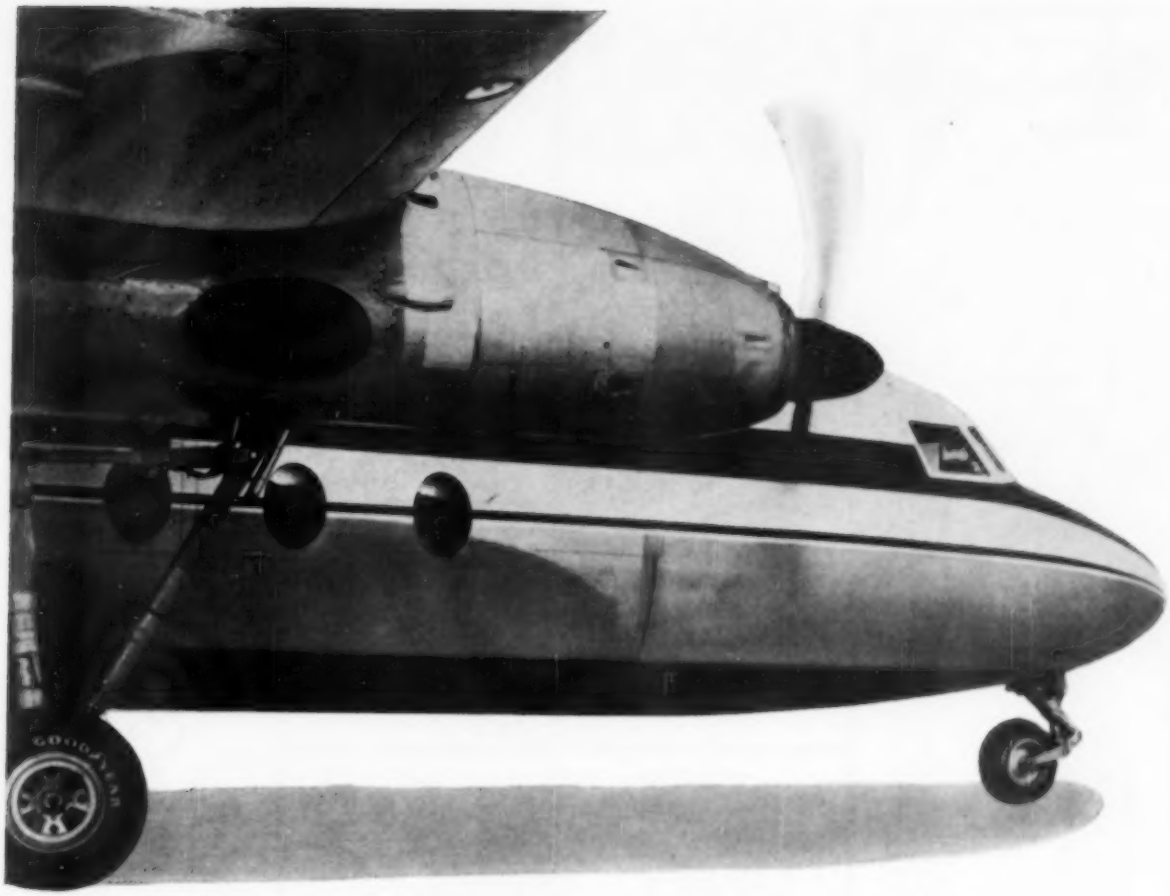
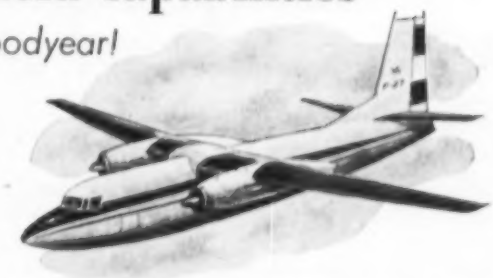


Propjet with shortfield capabilities

—brakes by Goodyear!



Tri-Metallic Brakes stop F-27 on 3,000-foot Airstrips

In the F-27, being produced by Fairchild Engine and Airplane Corporation, short-and medium-range operators at last get a propjet transport that combines much-needed speed with shortfield capabilities.

A good bit of the credit for enabling such a performer as the F-27 to use airstrips as short as 3,000 feet goes to its Tri-Metallic disc brakes.

Developed by Goodyear Aviation Products — which also supplied the long roll life, lightweight wheels for the aircraft — this new braking principle combines disc-brake efficiency with a new metallic lining material.

Requiring 200 fewer parts than comparable brakes, giving up to 50% increase in heat absorption per pound of brake weight, and needing no adjustment of any kind through the full life of the brake linings—the pneumatically operated Tri-Metallic Brake by Goodyear is the simple, dependable answer to aircraft design problems where speed, space and weight are critical factors.

WRITE—RIGHT NOW—for information on the brake that stops the hot ones, the big ones, the shortfield aircraft you're going to build! Address: Goodyear, Aviation Products Division, Akron 16, Ohio, or Los Angeles 54, California.

GOODYEAR AVIATION PRODUCTS

MORE AIRCRAFT LAND ON GOODYEAR TIRES, WHEELS AND BRAKES THAN ON ANY OTHER KIND

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with

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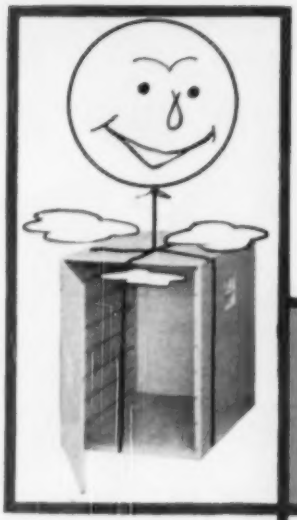
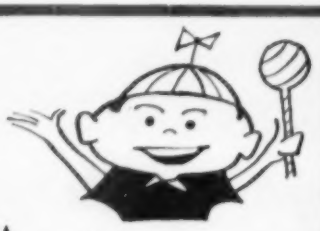


LIGHT WEIGHT

despite their strength these Buffet Inserts weigh no more than aluminum.

Airline users confirm that fiberglas reinforced plastic (F-R-P) Buffet Inserts now offered by Weber, provide numerous design performance and cost advantages. Compare the F-R-P inserts with metal "boxes"; note that plastic offers:



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bumping, kicking, jarring, even dropping . . . do not faze these resilient inserts.

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low cost molds mean Weber can economically build even a few units exactly as you'd like them. Minimum maintenance cost, too.

SMOOTH CONTOURS

no sharp edges or corners, inside or out: molded in one piece.

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Quiet (no clanging!),
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AVIATION CALENDAR

Nov. 25—Board of Directors Meeting, Air Transport Assn., Statler Hotel, Washington, D. C.

Nov. 26—Some Aspects of Refrigeration in Supersonic Aircraft, Library, The Royal Aeronautical Society, London, England.

Nov. 26—Annual Membership Meeting, Air Transport Assn., Statler Hotel, Washington, D. C.

Nov. 26-27—Eleventh Meeting, Aeromedical Panel, Advisory Group for Aeronautical Research and Development, Shoreham Hotel, Washington, D. C.

Nov. 28-30—Annual Snowbird Soaring Contest, Harris Hill, Elmira, N. Y.

Dec. 1-6—Annual Meeting, American Society of Mechanical Engineers, Statler-Sheraton McAlpin Hotels, New York.

Dec. 2-6—American Rocket Society, annual meeting, Hotel Statler, New York.

Dec. 3-4—Human Factors in Systems Engineering, Institute of Radio Engineers & Human Factors Society of America, Penn-Sherwood Hotel, Philadelphia, Pa.

Dec. 4-5—Symposium on high temperature strain gages, Aeronautical Structures Laboratory, Naval Air Material Center, Philadelphia 12, Pa.

Dec. 9-13—1957 Eastern Joint Computer Conference and Exhibit, Sheraton Park Hotel, Washington, D. C.

Dec. 16-18—Air Traffic Control Symposium, "The Mission and Methods of the Airways Modernization Board," sponsored by Franklin Institute, Philadelphia, Pa.

Dec. 18—Gas Turbine Development speaker: Rear Adm. S. B. Spangler, USN, Air Development & Material Center, at Engineers Club, Philadelphia, Pa.

Jan. 6-8—Fourth National Symposium, Electronics Reliability and Quality Control, Hotel Statler, Washington, D. C.

Jan. 13-17—1958 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

Jan. 14-15—Yankee Instrument Fair & Sym-

(Continued on page 6)

AVIATION WEEK • NOVEMBER 25, 1957

Vol. 67, No. 21

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To speed production and on-time delivery, the MC-1 Heat Exchanger is fabricated with special tools, custom designed and built by Lavelle. During a five-year period, frequent review of processing and tooling has enabled Lavelle to improve quality . . . *without* increasing cost to customer, despite rising labor and material costs.

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An important protector for the pilot is Firewel's new integrated oxygen system (F-17000*) . . . designed for the military pilot on altitude pressure suit flights, as well as on low altitude missions. Firewel is "keeping pace" with America's newest aircraft developments, sharing in the many speed and altitude record flights of both Air Force and Navy aircraft.

Dependable oxygen breathing equipment is Firewel's forte . . . regulators, cylinders, special systems for all high altitude pressure suit flights.

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AIRCRAFT REGULATING CONTROLS • OXYGEN BREATHING EQUIPMENT

AVIATION CALENDAR

(Continued from page 5)

posium, sponsored by Instrument Society of America (Boston, Connecticut Valley and Fairfield County Sections), Hotel Bradford, Boston, Mass.

Jan. 20—Winter Meeting, Provisional Western States Section, The Combustion Institute, California Institute of Technology, Pasadena, Calif. For details write: Mr. G. S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif.

Jan. 20-Feb. 7—Aviation Institute for Commercial Carriers and Business Pilots, Univ. of Southern California, Los Angeles.

Jan. 22-26—International Air Show & Exposition, Master Field, Miami, Fla.

Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, Main Auditorium, Engineering Societies Bldg., 29 W. 39 St., N. Y. C.

Jan. 30-31—American Society for Engineering Education, 1958 College-Industry Conference, University of Michigan, Ann Arbor, Mich.

Jan. 30-31—Seventh Annual Instrument Short Course, sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor College, Wilmington, Calif.

Feb. 3-4—Industry-Service Symposium, Flight Control-Panel Integration, Biltmore Hotel, Dayton, Ohio. For details write: Mr. J. H. Kearns, Box 942, Dayton, Ohio.

Feb. 4-6—Thirteenth Conference, Society of Plastics Industry, Edgewater Beach Hotel, Chicago, Ill.

Feb. 19—"Are Flying Saucers Fact or Fancy?", Dr. Hugh Winn, Missile and Ordnance Systems Department, GE, Engineers Club, 1317 Spruce St., Philadelphia, Pa.

Mar. 13-14—Second National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference, American Rocket Society-American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, managed by American Institute of Chemical Engineers, 25 W. 45 St., N. Y. C.

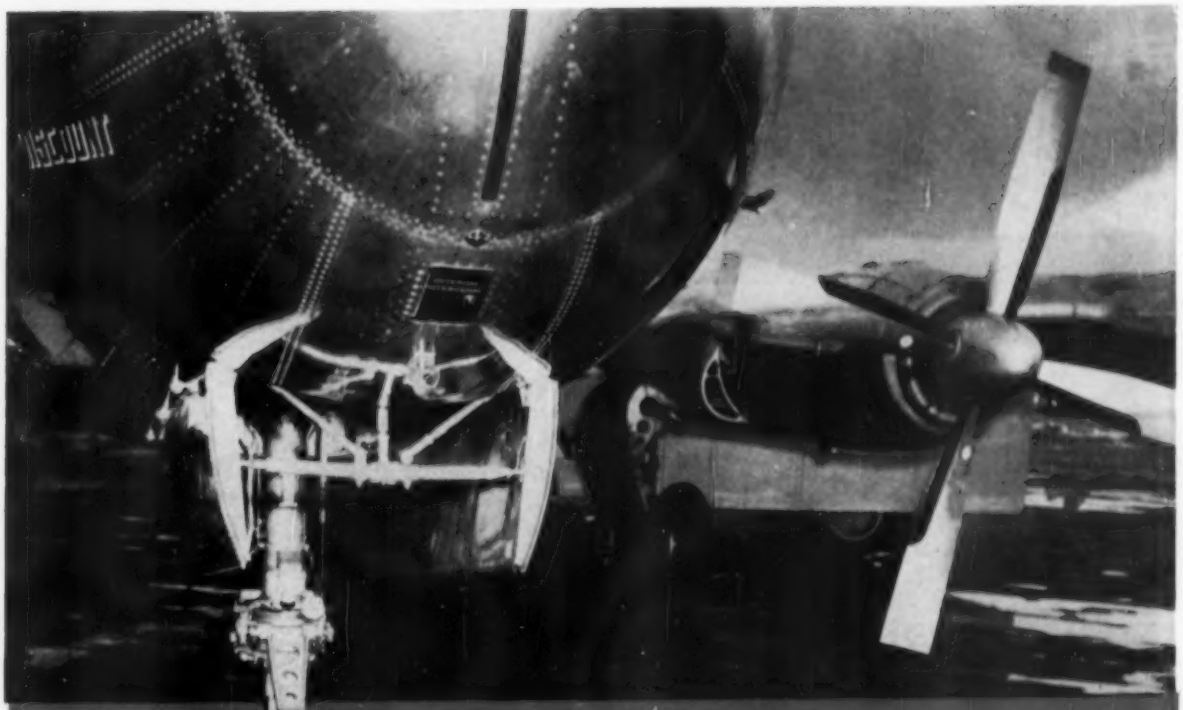
Mar. 18-19—First Interservice and Industry Symposium on Guided Missiles Training Equipment (limited to those with Secret clearance), Naval Ordnance Laboratory, White Oak, Silver Spring, Md. For details write: Mr. J. G. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, L. I., N. Y.

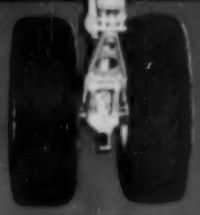
Mar. 24-29—Fourth International Instrument Show, Caxton Hall, Westminster, London.

Mar. 30-Apr. 1—RFC-RNAS Reunion, (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Apr. 8-10—Eighth International Symposia, Electronic Waveguides, Microwave Research Institute of Polytechnic Institute of Brooklyn, Engineering Societies Bldg., 29 W. 39 St., N. Y. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York.





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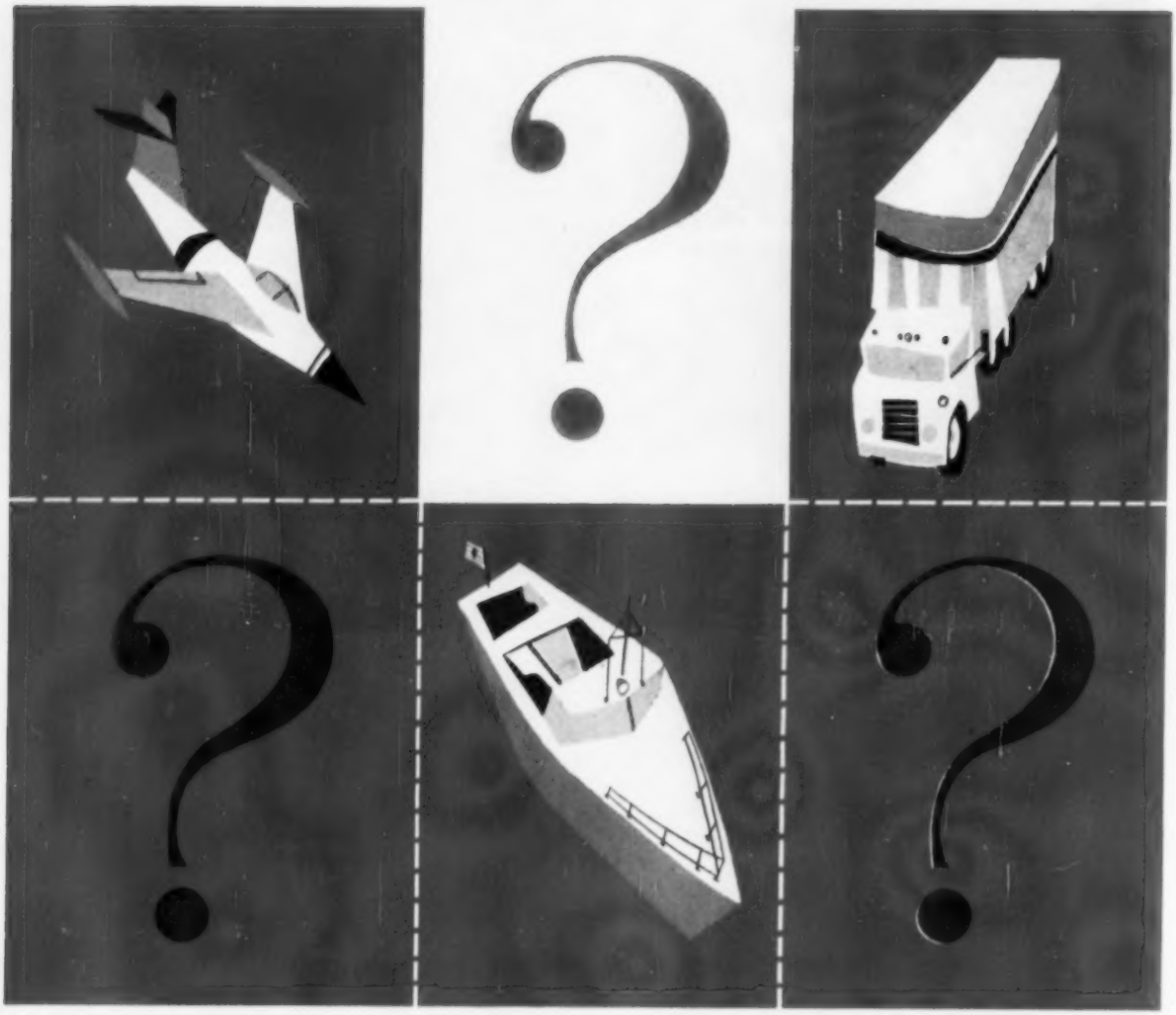

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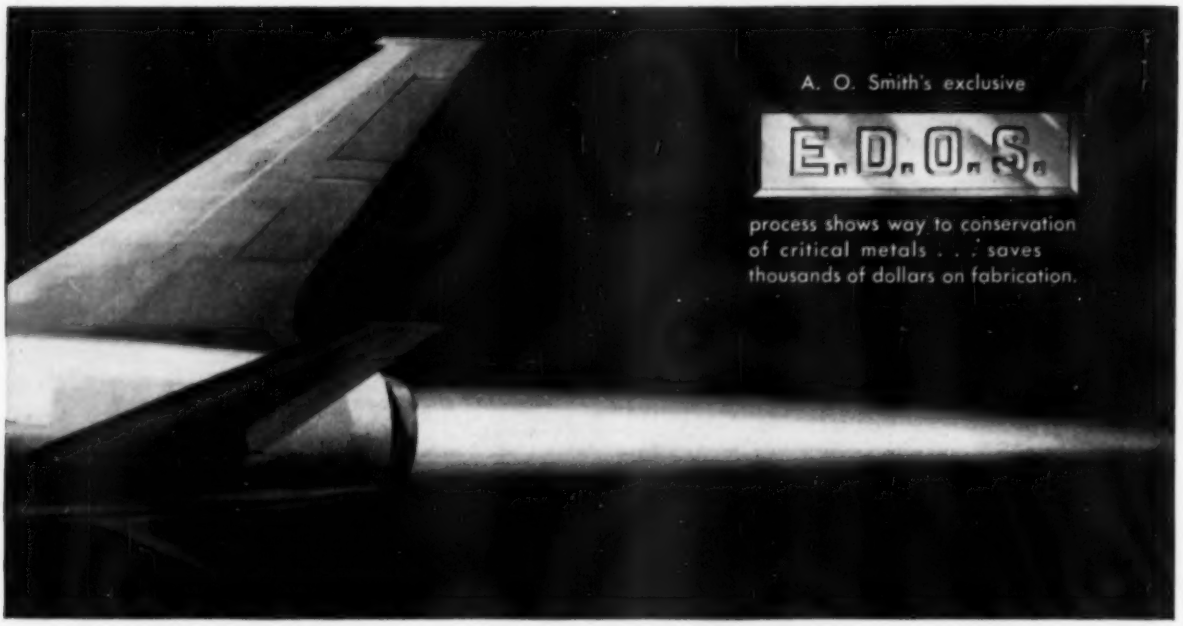
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process shows way to conservation of critical metals . . . saves thousands of dollars on fabrication.

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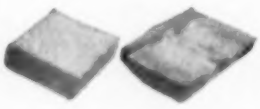

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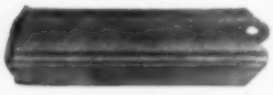
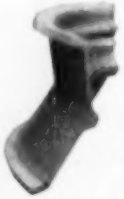


The second step involves pre-forging and an initial roll to form a piece of this configuration.



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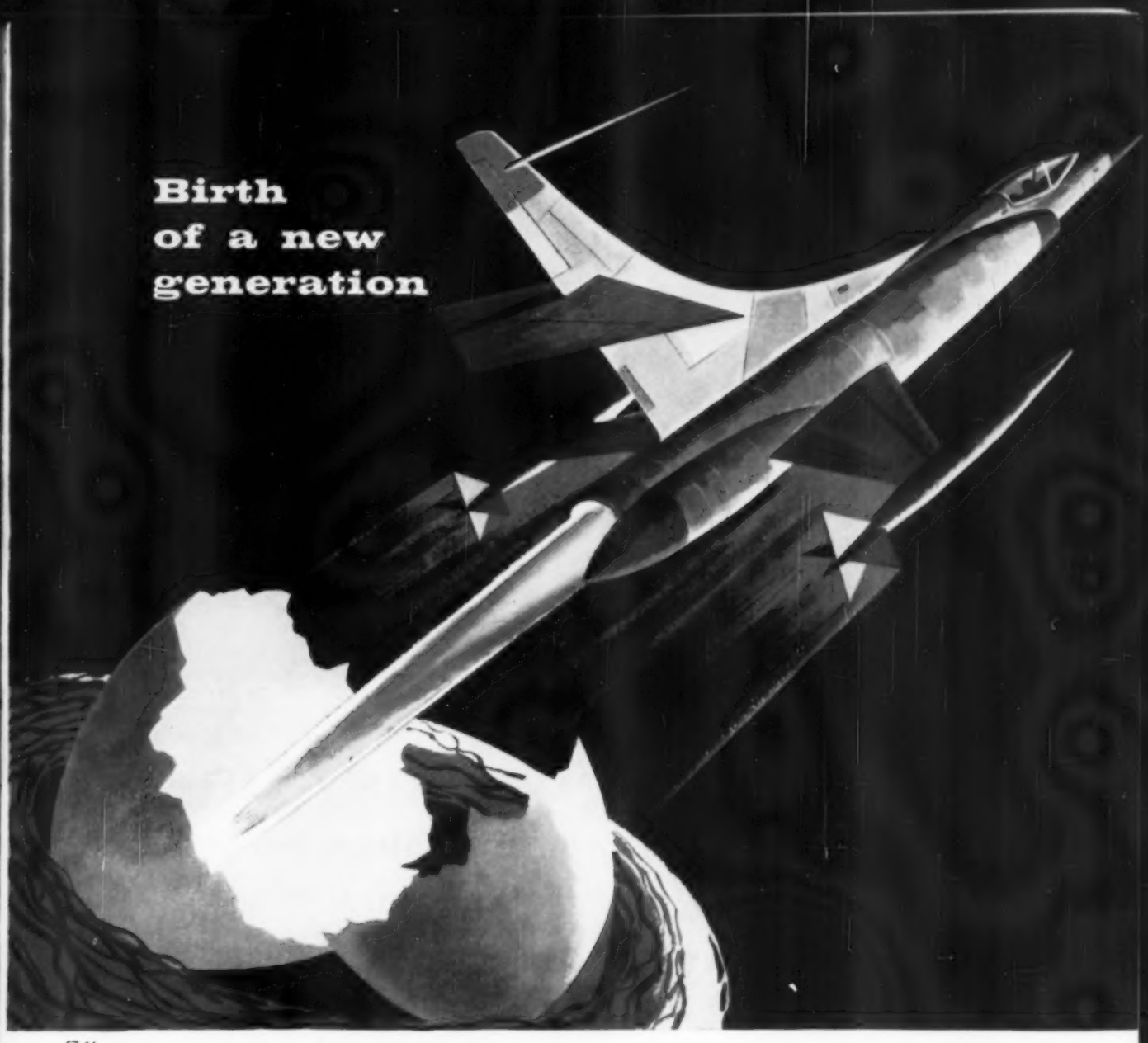

57-44

Future jets will be flying higher and faster than any now in the sky. This new generation of jets will use radically new products now in the development stage at Ex-Cell-O—builders of actuators, valves, fuel nozzles, blades, rotors, fuel controls, parts and assemblies.

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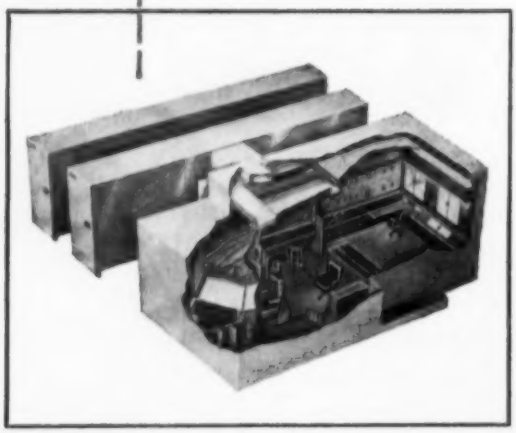

The recent globe-circling feat of the SAC, B52 in the amazing time of 45 hrs. 19 mins. could have been 5 to 6 hours less — if the all jet KC-135 had been in operation to perform the refueling. Very soon the KC-135 will become fully operational and the crews of these giant 500 mph. tankers will be *fully trained* — thanks to the ERCO Flight Simulator. ERCO — one of the recognized leaders in the field of synthetic training devices was selected to design and build the KC-135 Simulator.

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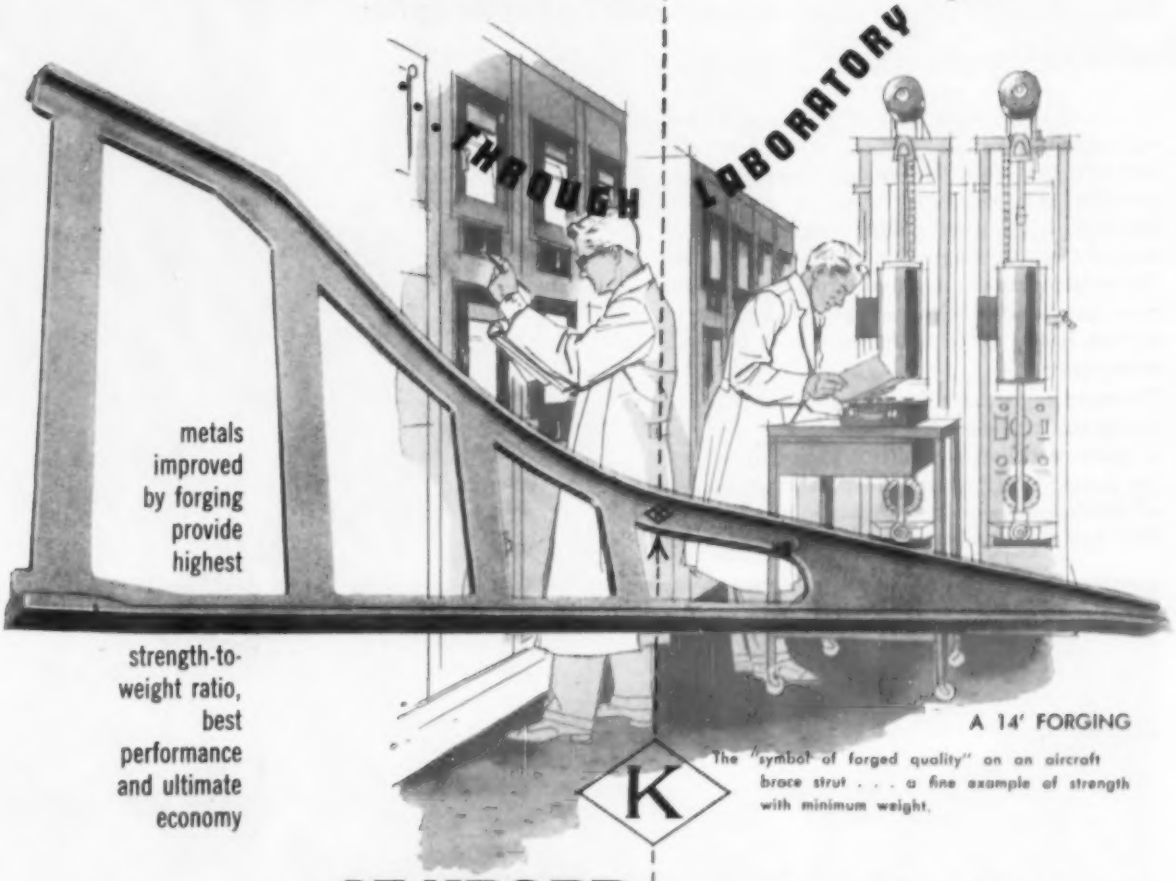

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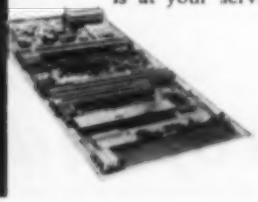

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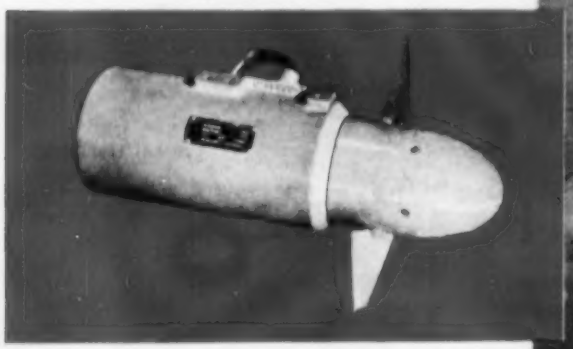

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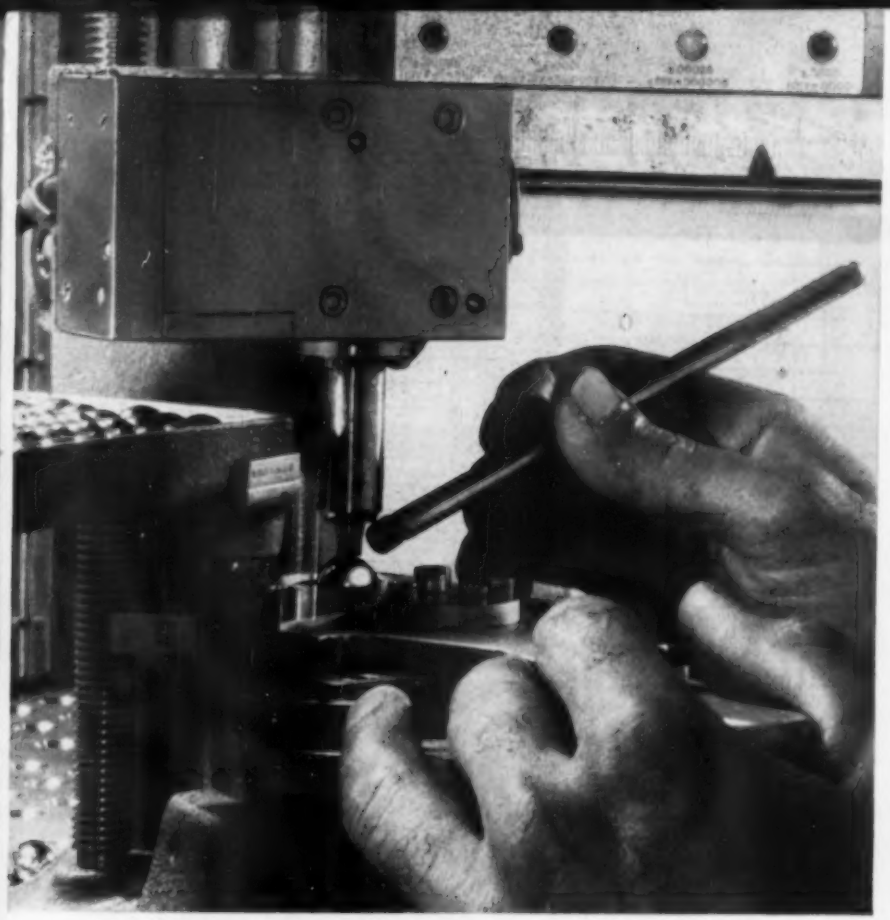

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☐ Descriptive bulletin, GEA-6274

☐ Theory of Operation, GET-2480A

☐ Immediate project ☐ Reference only

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Single Manager to Head Anti-Missile Push 26
► Army Zeus, USAF Wizard projects will be combined under single manager; other projects to follow.

Airlines Face Traffic-Jammed Winter 38
► Increased volume of instrument traffic saturates airways; airline performance may hit new low.

Rocketdyne Develops Missile Engines 86
► Propulsion systems with potential application to space flight also are investigated by division.

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COVER: Douglas Thor intermediate range missile accelerates after firing at Cape Canaveral, Fla. The Air Force IRBM, formed of three skin sections with milled waffle pattern on inside (AW Oct. 23, p. 23), is approximately 70 ft. long. Probe on blunt nose appears to be for instrumentation, the length necessitated because of the strong detached shock wave ahead of the blunt shape. Swiveling rocket is used for control. Engine is made by Rocketdyne Division of North American Aviation whose operation is described in detail in story on page 86.

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EDITORIAL

Aviation's Economic Stature

In the last few years, the aviation industry has become the dominant factor in setting the pace of this nation's economic cycle. This is the theme of a thoughtful and well documented article by economist Eliot Janeway in the current issue of the Harvard Business Review. Mr. Janeway's article merits careful study by aviation industry executives for two reasons:

• **It provides a sharp perspective** on the role of aviation and its supporting technologies in the overall national economy and details the influence of major aviation industry problems on the country's basic economic cycle. Aviation industry executives are so heavily immersed in a subjective attempt to cope with the swiftly, but not always surely, changing Pentagon signals that they have real trouble in attaining any sort of perspective on their galloping industry.

• **It raises interesting questions** as to the validity of government financing policies in relation to the real requirements of a sound, technologically modern defense program.

To give our readers a sample of Mr. Janeway's thesis we quote from his opening paragraphs:

"Nowadays all business calculations and economic theorizing must be viewed in the broad perspective of the competition—military, economic and political—between the Soviet and American systems. The continuing fact of this competition has made aeronautics—along with the related electronics, instrumentation, atomics and missile industries—the key to the overall United States business trend. And the key to this competition between the Soviet and United States systems is the concept of time—more specifically the unprecedentedly long lead times involved in the aeronautical investment cycle.

"This new combination—the U.S.-U.S.S.R. competition and the long lead times involved in trying to win this competition—means that the question nowadays is not *whether* we will continue to suffer inflation but *how much* and *how soon*.

Consequences of this new defense are as serious as they should be obvious: first, a steadily rising demand for money from both government and business and still more urgent a sharpening shortage of technical skills to put this money to work."

Mr. Janeway points out that the economic cycles of the past have been determined, first, by the quarterly investment cycle of the textile industry and, since World War I, by the annual cycle of the automotive industry. Since the Korean war, Mr. Janeway believes, the defense cycle, paced by the five to seven-year development cycle of aerial weapon systems, has become the dominant economic trend.

Mr. Janeway cites five principle characteristics of this new economic trend-making process:

1. Future growth in mass production and mass distribution industries will follow the overall trend instead of setting it as they have in the past. And the over-all trend will be set by a more dynamic sector of the economy, namely the aviation industry and its supporting technologies.

2. Aviation with its supporting industrial segments has become the largest single industrial source of demand for capital in the national economy.

3. The long lead time involved in the aeronautical investment process has altered the workings of the traditional business cycle by subjecting it to workings of the defense cycle.

4. Growth of aviation as the main investment force in the United States parallels an even more dramatic trend-making growth in the Soviet economy.

5. This change has also altered the traditional workings of the government fiscal operations. Thanks to workings of the aeronautical investment process, government spending and private corporate investment are now rising simultaneously—a new economic phenomenon.

We recommend a thoughtful study of Mr. Janeway's detailed analysis of these trends for an interesting approach to the future problems of the aviation industry within the shell of our national economy and international influence on the future.

—Robert Hotz

Quotable Quotes

"Sputniks, Muttniks, missile and rockets are but interim measures between manned high speed air-breathing vehicles and manned space flight. Whereas those who now have the capability to control the air, control the land and sea beneath it, so in the future it is likely that those who have the capability to control space will likewise control the earth's surface."

—Gen. Thomas D. White, chief of staff, U.S. Air Force.

"It is important to realize that the aircraft industry is the missile industry. The arts and sciences that have brought manned flight from the 42 mph. of the Wright Flyer to the supersonic aircraft of today are the same arts and sciences which, with greater refinement and sophistication, have made guided missiles a reality."

—Lt. Gen. Samuel E. Anderson, commander, Air Research and Development Command.

"The building of a modern high speed aircraft or missile has necessitated and brought into being a new concept of functional coordination and systems analysis in which many groups of professional specialists have joined talents to produce results beyond the ability of any single man or group. . . . Each new weapon is the embodiment of many research results in many fields. Its ancestry leads not to a single research project but to many carried out at many institutions and even in many countries. The base of this pyramid is very broad."

—Dr. Hugh Latimer Dryden, director, National Advisory Committee for Aeronautics.

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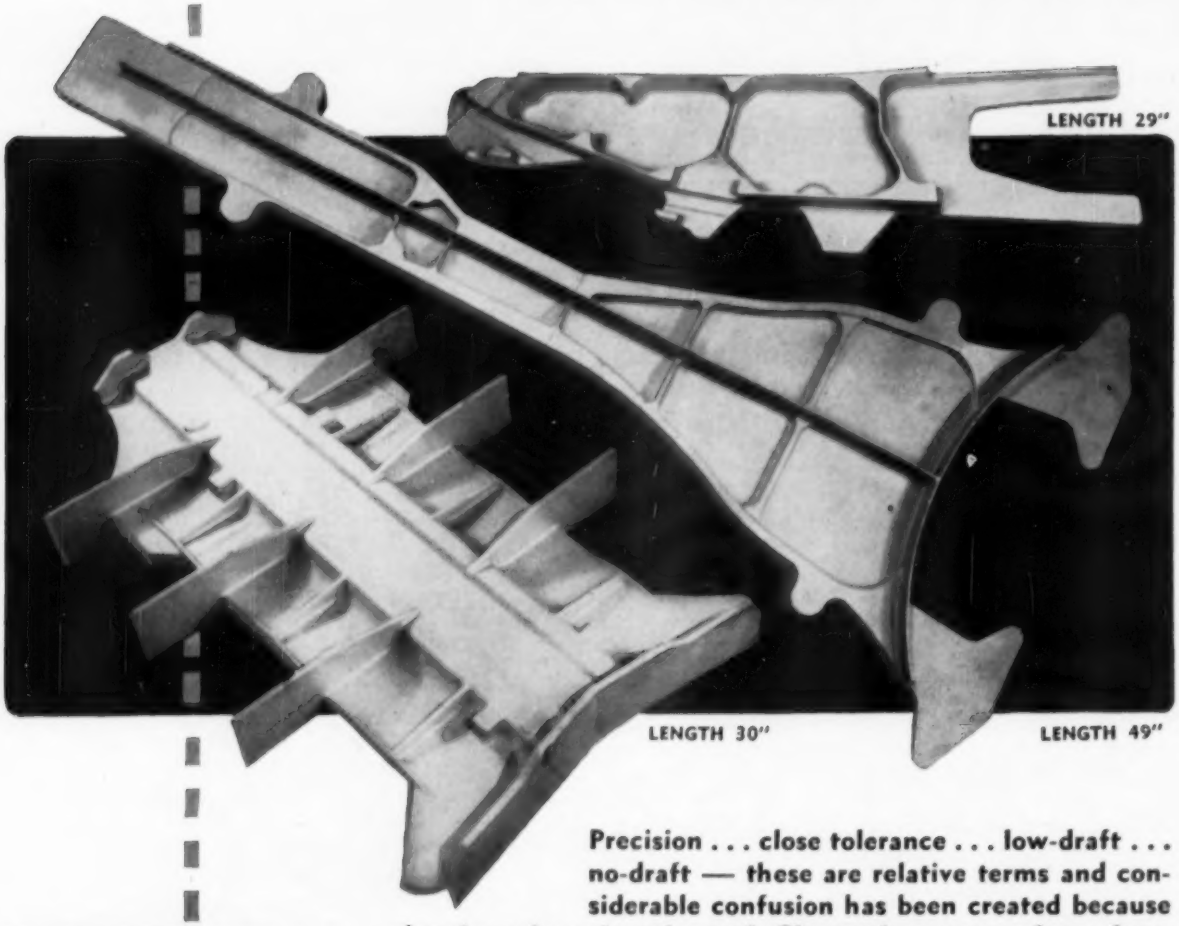

Precision . . . close tolerance . . . low-draft . . . no-draft — these are relative terms and considerable confusion has been created because they have been loosely used. Close tolerances on large forgings have been pioneered by Wyman-Gordon over the years. The degree of precision which is practical now becomes a question of economics.

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WHO'S WHERE

In the Front Office

George E. Carlson, board chairman, Minnesota Rubber and Gasket Co., Minneapolis, Minn. **Robert W. Carlson** succeeds Mr. George Carlson as president.

Wladimir A. Reichel, senior vice president, Norden-Ketay Corp., Stamford, Conn.

Richard W. Gilbert, senior vice president, Alaska Airlines, Inc. Also: **Chester L. Miller,** assistant vice president-operations.

John M. Embree, assistant to the president and new applications manager, Mid-Century Instrumatic Corp., New York.

William M. Crilly, assistant to the president, Hawaiian Airlines, Ltd.

Charles W. Carmody, Assistant Director, Office of Air Traffic Control, Civil Aeronautics Administration, U. S. Department of Commerce, Washington, D. C.

Honors and Elections

William V. O'Brien, a vice president of General Electric Company and general manager of the Apparatus Sales Division, has been elected president of the National Electrical Manufacturers Association, New York, N. Y.

John Maxian, Jr., chief electrical engineer of North American Aviation, Inc., has been named for membership as a Fellow of the American Institute of Electrical Engineers, one of the AIEE's highest recognition awards, "for pioneer work in the application of electrical engineering principles to the design of electrical equipment for aircraft."

Charles Ehmlinger of the University of Nebraska has received the University Aviation Association Award, which is presented annually to the person in college or university education circles making the greatest contribution to air age education.

Charles N. Kimberlin, Jr., assistant director of Esso Research Laboratories, has received the Southern Chemist Award for "advances . . . touching nearly every phase of the petroleum industry. His work in catalytic cracking, a process for producing aviation and high-octane motor gasoline, helped power World War II air defenses. . ."

Changes

Dr. Noah S. Davis, director-Special Projects Branch, Food Machinery and Chemical Corp., Buffalo, N. Y. Also: **John H. Keefe,** manager-Chemical Department, and **Erik Saller,** manager-Engineering Department, Special Projects Branch.

Ernest G. Stout, assistant manager-Washington, D. C. office, The Ralph M. Parsons Co., Los Angeles, Calif.

Rear Adm. George T. Mundorff (USN, ret.), executive assistant to the vice president-assistant general manager, Link Aviation, Inc., Binghamton, N. Y.

Donald E. Romine, general manager-engineering and production, International Radiant Corp., Westbury, N. Y. Also: **Karl D. Klein,** sales manager.

(Continued on p. 101)

INDUSTRY OBSERVER

► Only 16 tons of fuel would be required to send a mouse or guinea pig on a 12-day round trip to the moon, using an orbit calculated by computer at the Institute of Theoretical Astronomy of the U.S.S.R. Academy of Sciences. Fuel is needed only for takeoff; gravitational forces do the rest. Payload is 50-100 kg. Closest approach to the moon would be less than 18,750 mi. Trips out and back would require five days each and rocket would remain close to the moon for two days. Farthest distance from earth would be 260,000 mi.

► Douglas Aircraft and Magnavox are making a joint presentation to Bureau of Aeronautics for airplane sonobuoys similar to those now carried by Navy anti-submarine helicopters. Under Douglas-Magnavox plan, buoy would be lowered into the water during a tight turn. With a long enough line, buoy theoretically would remain almost stationary in the water during the turn, or turns, giving it time and conditions needed to survey the area. Aircraft Douglas would like to see used if the project is adopted is its 1906 turboprop STOL aircraft (AW April 1, p. 29)

► Thiokol Recruit rocket used as first and second stages of USAF's high-altitude rocket (AW Oct. 21, p. 30) and as powerplant for Lockheed X-17 research vehicle has a thrust/weight ratio of approximately 100. Recruit is nine inches in diameter, weighs 350 lb. and develops about 35,000 lb. thrust.

► Air Force is considering Chance Vought Regulus II 1,000-mile-range surface-to-surface missile as a successor to the 500-mile-range Martin Matador. Regulus II, developed for the Navy, is now being flight tested from Edwards AFB, Calif.

► Imaginative gravity experiment being considered by Air Research and Development Command is University of Detroit proposal to build 4,000 lb. flywheel which would be rotated at 100,000 rpm. so that hypothesized existence of gravity-like radiation of matter under high accelerations can either be proved or disproved.

► Flight test program of four-engine conversion of Grumman Goose twin-engine amphibian is scheduled to begin in approximately one month. Developed by McKinnon Enterprises, Sandy, Ore., converted aircraft will have supercharged 340 hp. Lycoming engines fitted with feathering and reverse-pitch propellers as replacements for the standard 400 hp. Pratt & Whitney Wasp engines. Gross weight of the conversion will be about 11,000 lb. as compared with about 8,000 lb. of the original aircraft. It will carry 550 gal. in fuel rather than the original's 220 gal. Aircraft also will feature retractable wingtip floats, picture windows and curved windshield.

► Swiss government is interested in limited purchase of Chance Vought F8U-2s, modified version of the F8U-1 (AW Nov. 18, p. 37). First F8U-2 is scheduled to begin flight tests this winter, and deliveries to the Swiss probably could begin late next year if Navy approved.

► Latest in the trend by both U. S. and Russian helicopter builders to clean up their aircraft (AW Nov. 18, p. 34) is Sikorsky modification of the S-58. Company has used simple sheet metal fairing to enclose rotor hub to improve top speed and cruise economy. Apertures are left for rotor blades.

► AiResearch Manufacturing Co., of Los Angeles, is supplying hydraulic power sources for Nike missile flight controls. A monopropellant drives an AiResearch turbine coupled to a Vickers hydraulic pump which charges a bootstrap accumulator.

► Russians have been exploring possibilities of hydrocarbons as nuclear rocket propellants for several years. Technical literature also has shown their interest in fluorine as an oxidant. Research has included studies of thermodynamic properties from 298K to 5,000K of F_2, HF, CH, CH_2 CH_3 and C_2.

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Washington Roundup

Balance The Budget

Statements by the White House, Defense Secretary Neil H. McElroy and his Defense Comptroller Wilfred J. McNeil indicate that the administration has not relaxed its determination to balance the budget despite the acceptance of higher defense costs to meet the Russian challenge.

While the President gained headlines with his acknowledgement that the Pentagon must have more money, both McNeil and McElroy have tried to discount any idea that there will be a substantial increase. The Secretary of Defense, who will be surprised if he gets through the present fiscal year without spending more than $38.5 billion, believes the Fiscal 1959 budget will run in the area of $40 billion.

It is clear that accelerated expenses to push the intermediate range ballistic missile program and supply the weapon to U. S. allies abroad, plus increased personnel costs and other rising expenses, will make this difficult.

The answer: military installations not essential to today's threat will be chopped back along with other activities not contributing to our technological race with Russia. Biggest damage probably will be suffered by the Army, which explains in large part Army's current effort to publicize its capabilities.

Holaday's Role

Redefinition of responsibilities of William M. Holaday says he will "direct all activities in the Department of Defense relating to research, development, engineering, production and procurement of guided missiles." He also has a new title: Director of Guided Missiles instead of Assistant to the Secretary of Defense.

Holaday's authority does not extend to the budget, and it does not cover the anti-missile missile, which will fall in the purview of the new single manager for research and development (see page 26).

Still unclear is Holaday's relationship with Dr. James R. Killian, now on the job as White House advisor on science and technology. In fact, Killian's whole relationship with the Pentagon is a matter of speculation. Defense Secretary Neil H. McElroy says it has not been spelled out, but Dr. Killian "is welcome here in any way in which he wants to give us his time." The Secretary rejected a suggestion that the White House technical expert may give orders to the Pentagon guided missile magnate.

Sharing the Burden

Despite Pentagon's easing of the economy-wave spending ceilings and the depth to which they will be felt by subcontractor and suppliers, some prime contractors are passing along at least some of the financial burden with their business.

One prime in the aircraft business has told its suppliers that the Defense Department spending ceiling, imposed with an appeal to maintain schedules, was "necessary in order to keep total government obligations within the debt limit." The contractor's edict:

"In order to meet this imposed financial burden, we find it necessary to defer payment of invoices commencing Nov. 1, 1957, on a net 60 day basis.

"When the military services resume their usual payment schedules, which is estimated to be about July 1, 1958, we will return to our usual prompt processing of invoices."

Airlines View Sputnik

Sputnik is having a dampening effect on airlines plans to launch their biggest campaign yet against the transportation tax. Air carriers had planned to pool the anti-tax program with other transportation organizations in a climactic move to either shave down or eliminate the tax entirely. A tax reduction would partially offset any effects a fare raise would have on the traveling public, helping to prevent the loss of economy-minded passengers. However, with the new emphasis on a missile defense program, airlines now feel any effort to reduce taxes probably will be wasted effort.

Re-Entry Solved

Watch for further fireworks over Army claim, voiced by President Eisenhower in his Nov. 7 "chins up" speech from the White House, that it has solved the re-entry problem for ballistic missiles.

Both Army Secretary Wilber Brucker and Maj. Gen. John Medaris, Redstone Arsenal boss, have reiterated the statement that the Jupiter C cone proves Army scientists have achieved the goal.

Subject will be probed at Senate Preparedness Subcommittee missile hearings on Capitol Hill which are scheduled to begin today, when other authorities are expected to challenge the Redstone claim.

Offer to Capital

Independent Airlines Assn. representing 29 supplemental carriers has offered to fly Capital Airlines routes without the subsidy the airline wants. The group said it had never asked for or received a "penny of federal subsidy and we are ready to fly Capital's routes on the same basis." Capital recently asked the Civil Aeronautics Board for a return to subsidy payments because of its critical financial condition (AW Nov. 11, p. 39). Meanwhile, Capital is opposing American Airlines' request to intervene in the subsidy case on grounds that its right to subsidy is governed by the Civil Aeronautics Act and not by the possibility that American has now decided that "the legislative provision for subsidy is no longer a completely wise policy." American's request to intervene was filed because, according to the carrier, the Capital petition raises a basic question of public policy: "Is it in the national interest to pit subsidized airlines against nonsubsidized airlines?" (AW Nov. 18, p. 39).

Defense Definitions

Defense Department last week described what it means when it reports that a missile has hit "an area of impact" and when it has hit the "target area." "Area of impact" means an area of about 2,500 square miles. This was reported to Rep. Dante Fascell (D.-Fla.) after he suggested that it "could mean an area of 10,000 square miles." The Department said its "target area" means an area "only a fraction of the size" of an "impact area."

—Washington staff

Single Manager to Head Anti-Missile Push

Army Zeus, USAF Wizard projects will be combined under single manager; other projects to follow.

By Claude Witze

Washington – Following White House orders, Defense Secretary Neil H. McElroy within the next month will appoint a single manager for research and development on weapon systems, handing over the anti-missile missile as the first project for the new office.

Both Army's Nike Zeus and USAF's Wizard projects will be amalgamated under the single manager, who will have control of personnel, budget and research facilities involved in the project.

The anti-missile missile, McElroy made clear, is only the first of the "upstream types of weapons projects" that will be denied to the armed services until they are through the research and development phase.

He referred specifically to future satellites, launched for military purposes, as another area where the new single manager will take charge.

Although details of the program clearly were lacking in all of the pertinent Pentagon offices, it appeared clear that the idea will be carried out in contradiction to many accepted tenets of the weapon system concept.

In addition, it appeared certain to face opposition from most military and industrial sources.

How McElroy Views System

The Defense Secretary, acknowledging that details of the single manager effort still must be worked out, described the idea in these precepts:

- **Defense Department** will not try to operate weapons in the field.
- **It will do research** and development to the point of operational capability, "because these weapons are not really in most instances likely to have any obvious individual service connection."
- **Object is to avoid** competitive effort by the services before Defense has decided which one will have the mission.
- **New weapons** will be turned over to an operating branch of the armed forces when they are about to become operational and "as far as possible before that."
- **Single manager** will assemble a "fairly substantial sized research and development effort" with "those people who have been working in these areas in the past as the nucleus."

McElroy's announcement followed by a week a statement by President Eisenhower that new programs will be put under a single manager and "administered without regard to the separate services."

It was clear that a raging competition between the Air Force and Army over the anti-missile missile would break into the open unless sharp executive action was taken.

McElroy's announcement was surrounded by a wave of claims of Army's prowess in the anti-missile missile field.

One report said the Army has Nike Zeus "in being." It developed that this means the weapon "partially exists in the form of research and development components."

Wide circulation also was given to a report that Army Chief of Staff Gen. Maxwell D. Taylor has urged McElroy and the Joint Chiefs of Staff to let the Army spend more than $6 billion in a three-year crash program to perfect the anti-missile missile. Both McElroy and the Joint Chiefs denied the report.

Service Confusion

A spokesman for McElroy told AVIATION WEEK that the single manager proposal had been discussed with the armed forces at a meeting attended by the Chiefs of Staff and others.

At the same time both USAF and Army personnel, as high as an assistant secretary, expressed amazement when it was called to their attention that their anti-missile missile projects will be taken over by Defense.

Five days after the McElroy announcement, an Army officer said, "This thing went right over my head, and I'm sure our R & D people don't know about it either."

On the other hand, Gen. Taylor was reported to be aware that his program "would undoubtedly come under the direction of a single administrator for all three services."

Observers here were of the opinion that, once the word gets down to the operating personnel, there will be violent protests against the change.

Industry Apprehensive

In addition to the military who will lose control of people, money and facilities to a new "czar" reporting to McElroy, industry contractors already are showing signs of apprehension.

In particular, aircraft industry prime contractors already have voiced their opposition to the "arsenal concept" of development, and they can be expected to frown upon the new single manager concept for the same reason. Primarily, this involves the costly and slow transition of an item from the plant of its developer to the plant of the producer.

On top of this, military officers in charge of training, maintenance and operations and logistics almost certainly will show concern over the intention to turn a new weapon over to some branch or branches of the armed forces when it is "about to become operational."

On the surface, this would appear to ignore the fact that the user sets down the requirement and defines the capabilities of a new weapon.

In the Air Force, for example, the development cycle starts with a General Operational Requirement (GOR) drafted by the using command. It is intrinsic to the weapon system concept that all units concerned have representation in the office of the Weapon System Project Office (WSPO) from the time that the design first goes on paper and long before metal is cut.

Frequently there is a great deal of research to be done before problems of training, facilities, logistics and maintenance can be fully faced, and the time consumed in this work can take as many months as it takes to get a test quantity of the weapons out of the manufacture's plant.

Jupiter-Thor

Washington—Defense Secretary Neil H. McElroy indicated last week that both the Army Jupiter and the USAF-Douglas Thor intermediate ballistic missiles may be produced.

He also announced that Britain and other allies will get U. S.-built IRBMs in 1959. This presumably would be the Thor, which could be in production to meet such a deadline.

McElroy also said he is optimistic about the Navy-Lockheed Polaris program and indicated that the submarine-launched fleet ballistic missile may be given a higher priority as part of a general effort to accelerate production of ballistic missiles in this range.

There was no doubt that the action was announced because of Soviet advances. While the official administration policy was one of discounting Russia's capabilities, McElroy said bluntly that "it seems rather obvious that we are behind the Russians."

Secretary of State John Foster Dulles said that both missile sites and nuclear weapon stockpiles for use by our allies will be set up in Europe, under NATO cognizance.

F-107 Turned Over to NACA

North American F-107A fighter-bomber, canceled before reaching production by USAF, has been turned over to the National Advisory Committee for Aeronautics high-speed flight station, Edwards AFB, Calif. NACA will evaluate its all-moving vertical tail, overhead engine air inlet and spoilers for lateral control rather than ailerons. F-107 is capable of Mach 2 in level or normal climbing flight and will exceed Mach 1 in a vertical climb. Maximum air speed is over 1,300 mph. It is powered by the Pratt & Whitney J75 rated at more than 15,000 lb. thrust. Like its predecessor, the F-100, the F-107 has automatic leading edge slats and all movable horizontal stabilizer.

Best contemporary example of this is the long program carried out by Air Materiel Command to provide efficient logistics for operational ballistic missiles (AW Aug. 19, p. 26). Army has a similar program for its Jupiter intermediate range ballistic project, with emphasis upon mobility for the operating forces.

The McElroy spokesman indicated that the administration does not consider these matters as serious impediments to putting research and development of new weapons under a single manager.

There was some speculation that interservice rivalries over the development and use of new weapons was not the only situation behind the White House-Pentagon decision to turn to a single manager.

Another possible factor was a recommendation early this year that all research and development funds be appropriated to the Secretary of Defense and programmed by his office. This proposal was advanced before the House Committee on Appropriations by the U. S. Chamber of Commerce (AW May 20, p. 25).

The Chamber, intent upon slashing the Defense budget, managed to unify the Army, Navy and Air Force to the extent that they all condemned the proposal. They found no sympathy for the Chamber's contention that if research and development "were properly integrated, the elimination of duplicate and/or triplicate building of facilities and staffing of such installations might well bring substantial savings to the taxpayers."

Nothing has been heard of the Chamber's suggestion that there be control of research and development only in the office of the Secretary of Defense since the committee hearings, but it is possible that the idea has been promoted strongly at the White House.

Swiss Hunter Order

Geneva—Swiss federal government has been asked to buy 100 Hawker Hunter F.6 aircraft for 1959 delivery as a first stage in re-equipping the air force.

Choice of suitable multi-purpose fighters for the Swiss air force had been narrowed down to the Hawker Hunter and the Swiss-built P.16 (AW Sept. 16, p. 65).

Missile Blackout Blamed on White House

By Katherine Johnsen

Washington—Evidence that President Eisenhower has been only sketchily briefed on guided missile programs in the past and that the White House directed a virtual blackout on the release of missile information was presented last week at sessions of the House Information Subcommittee. Man behind the blackout, according to the subcommittee: Robert Cutler, the President's special assistant for national security affairs.

Trevor Gardner testified that during his three years as Assistant Secretary of the Air Force for Research and Development from 1953 to February, 1956, the President was briefed twice on USAF missile programs—at one 45-minute session and at another meeting which lasted "eight or ten minutes."

'No Publicity'

Gardner said the Air Force was instructed to present the President "solutions, not problems." He said the President "wanted no publicity on guided missiles" and that "almost every time" missile information appeared in the press there was a complaint from the White House.

Rep. John Moss (D.-Calif.), chairman of the subcommittee, later named Robert Cutler as the person most responsible for the missile blackout. Noting Cutler's "dim view of the public's right to know," Moss declared that "with Mr. Cutler advising . . . it is little wonder . . . that former Assistant Air Force Secretary Trevor Gardner found that Mr. Eisenhower repeatedly opposed public information about the nation's missile programs."

Two major developments were:

TREVOR GARDNER

• **Official documents** vindicated Gardner in a direct clash with Murray Snyder, Assistant Secretary of Defense for Public Affairs, over whether Gardner announced without approval the existence of USAF's Falcon air-to-air missile.

Gardner testified that he was censored by President Eisenhower for mentioning the new missile in a Mar. 15, 1955, speech, despite the fact that his remarks had been cleared by the Department of Defense. Snyder flatly countered that this was not so, that mention of "Falcon was not in the original text."

Actually, a Department of Defense press release on the Falcon was handed out before Gardner made his speech in Dayton, Ohio. The release was timed to coincide with the speech. Marked "Hold for release until 10 A.M. (CST) . . . Mar. 15," the Defense Department release is entitled, "New Air Defense Rocket Described by Secretary Gardner" and begins: "First details of the Falcon Guided . . . etc."

Defense Department also had already approved a Mar. 15 release of background information on the Falcon by Hughes Aircraft Co.

• **Subcommittee began an investigation** of the practices of the Operations Coordinating Board at the White House which establishes final policy on missile information. Moss reported that the subcommittee will "document, for the first time, the part played by this highly hush-hush agency within the White House which apparently is calling the signals on what the American public will be told in the life-and-death competition with Russia." Cutler is vice chairman of the group which includes the Under Secretary of State, Deputy Secretary of Defense, Director of Central Intelligence Agency, and Director of the U. S. Information Agency.

Furnas Testifies

Dr. Clifford Furnas, former Assistant Secretary of Defense for Research and Development also denounced the secrecy which has existed until recently on missile firings. He told the subcommittee that with more information "the American people would have had more confidence" in the program.

Snyder, in turn, promised that there will be "further loosening" of information on firings and that "failures" as well as successful launchings will be reported. He said the press will be permitted to view the launching of the 20-inch earth satellite planned for March, but that lack of facilities would prevent press participation in the earlier launchings of smaller test satellites.

Attacking "preoccupation with secrecy," Moss protested that "under Mr. Cutler's philosophy, the American people are to be denied the facts affecting national survival. This is the kind of thinking which Mr. Cutler himself said decided against telling the American public the truth . . . about deficiencies in our continental early warning system and in our ability to defend against atomic attack." Moss charged that Cutler's policy "is apparent in the failure to inform the public of the nation's missile-satellite deficiencies until Sputnik sailed across the skies."

Moss noted that two months before the Oct. 4 launching of Sputnik I, the Library of Congress received copies of the Russian magazine, "Radio," giving details of the satellite, but that Rear Adm. Rawson Bennett, Chief of Naval Research, did not receive a translation

Atomic Plane Acceleration

Washington—Administration, convinced there is a strong possibility that Russia may fly a nuclear-powered aircraft before the U. S. combined with a propaganda effect not unlike that touched off by the Sputnik satellites, is acting to accelerate the program.

Defense Department and the Atomic Energy Commission have now agreed to give USAF Maj. Gen. Donald J. Keirn fully-defined authority over the project and over nuclear propelled missile programs.

AEC disclosed last week that it spent $86.7 million in Fiscal 1957 on aircraft propulsion research and development. This was 67% above the $52 million figure for Fiscal 1956.

Spending for construction work to facilitate the program jumped last year to $6.2 million, up 158% over the 1956 total of $2.4 million, indicating that the program will be further accelerated.

There is opinion in the Air Force that the operational problems connected with the atomic airplane are of such magnitude that the project does not deserve a top priority. However, slashing of red tape to facilitate the work is looked upon by the political administration as a worthwhile effort in the light of the new realization that technological achievements carry weight in world affairs.

until Oct. 3. He also pointed out that months before the Sputnik launchings, the Rand Corp. furnished USAF comprehensive information on Russian satellites and plans (see page 30). "What the Air Force did with it, we do not yet know," Moss commented. "But we do know that the American people were never forewarned."

Information Bog

Other testimony before the subcommittee included:

• **Both Furnas and Gardner urged** a Defense Department wide system of security clearance and elimination of the "need to know" requirement for access to classified information. "If you knew what was there, you wouldn't need to know," Furnas said.

• **With qualification,** they recommended an increase in the exchange of information among the services. Furnas reported that there was a delay of several months in the anti-missile missile program and the anti-radar missile program because of the services' reluctance to participate in joint briefing sessions. He said he hesitated to use his authority as an Assistant Secretary of Defense and "go to the boss" to force inter-service cooperation. He cautioned, however, that informational exchanges in the planning stages would be "useless" and would involve such a quantity of information that the volume would be "a deterrent" to progress. Gardner suggested that "sometimes it might be a good thing" not to exchange information among the services, adding that the advantages of competition should be weighed against the advantages of interchange. "Sometimes 10 minds are better than 100 or 1,000," he commented.

• **Snyder reported** that he "learned from the newspapers" that each of the three services had banned comments on satellites for fear of "misinterpretation" shortly after the launching of Sputnik I. Rep. Dante Fascell (D.-Fla.) insisted that "someone must have told them to do it." A memorandum of USAF's Air Research and Development Command stated that "the President desires that Air Force personnel refrain from making public comment on the satellite program of the U.S. and other countries." (AW Oct. 21, p. 28).

• **Snyder asked the subcommittee** not to press for declassification of information on the airport development program in which Pan American Airways participated, beginning shortly before World War II. This would involve "grave security consequences to the U.S.," he said.

• **Snyder told the subcommittee** he had protested the issuance of a memorandum by ARDC which directed that public statements not be made "which may prove embarrassing." Snyder said the ARDC order showed "lack of judgment," was contrary to "specific directives" of the Secretary of Defense, and that the individual responsible should be "censured."

• **Vice Adm. John M. Hoskins,** director of declassification policy for the Secretary of Defense, reported that he wants to have all information prior to Jan. 1, 1946, automatically declassified. He said that since July the number of Defense Department personnel authorized to originate the "top secret" classification has been reduced from 4,672 to 325. To facilitate future declassification, he said personnel classifying documents are required to explain their "thinking" in making a classification.

Cutler Denies 'Boycott' Accusation

Washington—Robert Cutler, special assistant to the President for national security affairs, has formally denied to the House Government Information Subcommittee that he accused AVIATION WEEK of treason or suggested an advertising boycott. Cutler's alleged remarks came after the magazine revealed that Russian missile firings have been tracked by the U.S. from Turkey for more than two years (AW Oct. 21, p. 26).

But Chairman John E. Moss (D.-Calif.) said businessmen who attended a closed dinner for the Commerce Department's Business Advisory Council last Oct. 26 have told the subcommittee Cutler charged the magazine "with rendering a great disservice to the nation" and "suggested that businessmen take the journal's alleged disservice into consideration when they place their advertising."

Cutler is chairman of the National Security Council's Planning Board, and a member of NSC's Operations Coordinating Board and the Council on Foreign Economic Policy.

Following news stories regarding Cutler's remarks at the closed meeting, Cutler denied through White House Press Secretary James Hagerty that he had accused AVIATION WEEK of treason or suggested a boycott.

Hagerty quoted Cutler as saying he had told the businessmen the Turkish radar story was "not treason but a shameful thing" and "probably would be a crime under law." Hagerty said Cutler told him "at no time in the speech" did he mention treason or advertising.

'Probably Advertisers'

In a letter replying to the subcommittee's request for an explanation, Cutler said:

"To illustrate difficulties facing a free nation in the continuing struggle with international communism, I mentioned a story recently published in a weekly trade journal, not identified by me by name (but in which I stated that some of my listeners were probably advertisers).

"The story purported to give details about an overseas installation and its contribution to free world defense.

"I remember saying that the publication of this story was in a category of things prejudicial to our nation and its people in the free world struggle for survival. I explicitly stated that the publication of the story was not treason.

"I did not state that any advertiser should boycott the magazine."

Moss' Reply

Rep. Moss said he made public the correspondence with Cutler at the request of members of the press after the subcommittee staff had checked with members of the council who attended the dinner.

"Those present (at the dinner) report that Mr. Cutler did not identify the publication," Moss said. "But the story in question had been front page news in virtually every newspaper in the country only a few days before, and the newspapers prominently identified the journal (AVIATION WEEK) as the source of the information about the missile-tracking station in Turkey.

"In commenting on Mr. Cutler's remarks, I am in no way passing judgment on the information disclosed. If a responsible government official alleges that there has been an unauthorized disclosure of properly classified information, his only proper course of action is to make his charges openly and take the steps provided by law.

"The questions arising as a result of Mr. Cutler's remarks illustrate the evils of secrecy imposed on meetings of the Business Advisory Council. This secrecy is defended on grounds that the government can obtain candid advice from businessmen only at off-the-record meetings.

"When secrecy is extended to dinner meetings at which government officials are enabled to make remarks for which they are not publicly accountable, the argument for secrecy becomes untenable."

Moss blames Cutler for much of the unnecessary secrecy surrounding U.S. military programs (see page 28). Moss also said Cutler claims credit for having established the Commerce Department's Office of Strategic Information to censor unclassified information. The office was abolished following Moss' subcommittee investigations (AW July 1, p. 25).

Red Sputnik Plans Available Last June

By Evert Clark

Washington—Approximate date of the launching of Sputnik I was available to the U. S. government in an official report written last June 21 and widely circulated by Sept. 1. Sputnik I was fired into its orbit on Oct. 4.

This same report pointed out that Russia was almost certain to capitalize on "the prestige and propaganda value to be gained" by launching its earth satellite ahead of the U. S.

President Eisenhower said at his first post-Sputnik press conference on Oct. 9 that he had no advance information that a Russian satellite launching was imminent.

Failure to partially counter the Russian propaganda and prestige gain in advance by taking the initiative and announcing what the Soviet Union was about to do illustrates one of two major problems in the scientific and technical information fields:

- **Failure to acquire,** index, classify, abstract and disseminate properly the vast amount of scientific technical literature available in this country and abroad.
- **Failure to act** on it properly even when it is acquired.

Evidence of Russia's intention to make the greatest political use of technological achievements in the International Geophysical Year, especially in astronautics, has been abundant and has reached this country in quantity.

Rand Memorandum

The prediction of the "distinct possibility" that Russia would attempt a satellite launching on Sept. 17 is contained in a Research Memorandum (1922) written by F. J. Krieger and published by the Rand Corp., a study group sponsored almost exclusively by Air Force and the Atomic Energy Commission.

Advantages to be gained by being first with a satellite "present a circumstance far too attractive for the opportunists in the Kremlin to ignore," Krieger concluded.

Krieger's memorandum is Part II of A Casebook on Soviet Astronautics. It quotes Academician A. N. Nesmeyanov, president of the U.S.S.R. Academy of Sciences, as saying in Komsomolskaya Pravda last June 9 that "soon, literally within the next months, our planet earth will acquire another satellite. . . . The technical difficulties that stood in the way of the solution of this grandioise task have been overcome by our scientists. The apparatus by means of which this extremely bold experiment can be realized has already been created."

Eight days earlier, in Pravda, Nesmeyanov had said: "As a result of many years of work by Soviet scientists and engineers to the present time, rockets and all the necessary equipment and apparatus have been created by means of which the problem of an artificial earth satellite for scientific research purposes can be solved."

Soviet Astronautics

After an extensive survey of recent Russian technical and popular literature, Krieger reported the "distinct possibility" that the Soviets would try for Sept. 17, anniversary of the birth of Russian astronautics pioneer Konstantin E. Tsiolkovskii, "though it comes rather early in the current IGY." One factor supporting this conclusion, he said, was postponement of the firing of the first Project Vanguard satellite to late 1957 or early 1958.

Six months before Part II of the Casebook was written, Krieger reported in Part I (RM 1760) that three basic reasons probably were behind Russia's increased effort to publicize its interest in astronautics—and the first of these reasons was propaganda.

Rand does not publicize the circulation of its research memoranda, but there is little doubt that officials connected with Project Vanguard and various U. S. missile programs received

Tsiolkovskii: 'Earth Is a Cradle'

Washington—Russia's interest in space flight begins with her 19th Century pioneer Konstantin E. Tsiolkovskii, who said: "The earth is a cradle of the mind, but one cannot live forever in a cradle."

But evidence of the Soviet Union's more recent and more intense interest in cosmic conquests dates back to Nov. 27, 1953, when Academician A. N. Nesmeyanov, president of the U. S. S. R. Academy of Sciences, told the World Peace Council in Vienna: "Science has reached a state when it is feasible to send a stratoplane to the moon, to create an artificial satellite of the earth."

This statement was "the signal to begin wide-scale publication of articles and books on space flight," according to F. J. Krieger of the Rand Corp. In Part II of A Casebook on Soviet Astronautics (RM-1922), Krieger traces subsequent events that made Russia's intentions quite clear. A summary follows:

- **K. E. Tsiolkovskii Gold Medal. Established Sept. 24, 1954, by the Presidium of the U. S. S. R. Academy of Sciences for outstanding work in interplanetary communication to be awarded every three years beginning in 1957.**
- **Commission on Interplanetary Communications. Established by the Presidium as a permanent interdepartmental group shortly after creation of the Tsiolkovskii Medal, to "coordinate and direct all work concerned with solving the problem of mastering cosmic space."**

"Academician L. I. Sedov, a top-notch hydrodynamicist, was appointed chairman and M. K. Tikhonravov—who designed and successfully launched liquid propellant research rockets in 1934—was appointed vice-chairman," Krieger said.

- **Two Soviet delegates, Sedov and K. F. Ogorodnikov, an English speaking astronomy professor from Leningrad State University, attended Sixth International Astronautical Congress at Copenhagen in August, 1955. This was the same month the U. S. announced its Project Vanguard.**
- **U. S. S. R. Academy of Sciences applied for membership in the International Astronautical Federation in 1956. At the Seventh Congress in Rome in September, 1956, the application was accepted and the lone Soviet delegate—Sedov again—was elected an IAF vice-president.**
- **"Uncommunicativeness" ended last December when Academician A. A. Blagonravov, armaments specialist and Presidium member, led a delegation of 13 scientists to the First International Congress on Rockets and Guided Missiles in Paris. Summarizing some of the papers presented, Blagonravov wrote in June that cosmic ray investigations by means of rockets began in Russia in 1947, that atmospheric composition studies to 100 km. altitude began in 1949, and that systematic studies of the atmosphere, including the use of dogs, were conducted from 1951 to 1956.**

Krieger's study, completed last June, concluded that Russia might well attempt to launch its first satellite on Sept. 17, of this year, the 100th anniversary of Tsiolkovskii's birth date; partly because the "prestige and propaganda value to be gained from a premier launching of an earth satellite whether instrumented or not, undoubtedly present a circumstance far too attractive for the opportunists in the Kremlin to ignore."

the report titled Part II of the Casebook.

Armed Services Technical Information Agency (ASTIA) also listed the report as ASTIA Document Number AD 133018. The report is considered a working paper that may be expanded, modified or withdrawn at any time. Views, conclusions and recommendations expressed in it "do not necessarily reflect the official views or policies of the U. S. Air Force," the report says.

In addition to comments on satellites, the technical and semitechnical papers covered by Krieger document Russian interest in high-energy fuels, atomic rockets, manned satellites, space stations and interplanetary flight.

Russian technical literature on astronautics also contains "a wealth of evidence of native competence" and "clearly indicates that the Russians possessed a relatively high degree of technical sophistication more than two decades ago," Krieger said.

One recent paper, which Krieger said is "probably (the) most startling disclosure in connection with Soviet space flight activities," speaks of 600 trajectories for flights to or around the moon, calculated by computer in a two-year study.

Although the Rand study represents good acquisition and quick assimilation and distribution of technical information, it is not typical of the general handling of such information in the U. S.

A study of Russian and U. S. programs, written by Jennie and Herschel Clesner and printed in the current Federal Bar Journal, charges that:

• **Russia not only** makes better use of her own scientific, technical and engineering information than the U. S. but makes better and more rapid use of U. S. information that the U. S. does.

• **U. S. has no central clearing house** for such information even though authority for it has existed for 11 years by executive order and for seven years by legislative act.

Russia's information institute, created in 1952, has a permanent staff of 2,300 translators, abstractors and publishers, supplemented by more than 20,000 cooperating professional scientists and engineers throughout the U.S.S.R. who serve as part-time translators and abstractors in their specialized fields, the Clesner study shows.

The institute publishes 13 "abstract journals" containing 400,000 abstracts culled from more than 10,000 journals from more than 80 countries. Some 1,400 of the 1,800 scientific journals published in the U. S. are translated, indexed and abstracted. Perhaps most useful are the 20 Express Information Journals, designed to give key Soviet scientists and industries summaries of foreign technological developments within two or three weeks.

Army Unveils Satellite Plans

Army last week revealed the first details of its satellite project and displayed the instrumentation package, here held by Dr. William H. Pickering, director of the California Institute of Technology Jet Propulsion Laboratory. Satellite will not separate from last stage of rocket, a modified Army Jupiter C. Instrumentation, formerly Package 2 in Navy Vanguard program designed mainly for cosmic ray study, is slightly over a foot long and weighs 20 lb. Jet Propulsion Laboratory is playing role in Army program similar to that performed by Naval Research Laboratory for Vanguard.

At least one U. S. scientist familiar with programs in both countries has proposed a comprehensive plan for improving this country's program. He is Dr. Harold Wooster, director of research communication for the Air Force Office of Scientific Research. He urges five immediate steps:

• **Increased support of** ASTIA. Created in 1952, ASTIA was given a firm annual budget ceiling of $2 million. This year Air Research and Development Command, which pays for ASTIA's housekeeping expenses, has contributed an additional $700,000. Wooster estimates ASTIA needs a $3 million budget and 45 additional personnel to carry what should be its present workload, and more to increase it. ASTIA is a tri-service agency directed by a Defense Department-level policy council. It has 500,000 reports on government research and development and circulates about that number annually, here and in NATO countries.

• **Creation of a long-range** planning group on resources and need for search of published scientific information.

• **Creation of an express abstracts** service for scientists in defense work.

• **Creation of a central abstract** agency that would pool the efforts of a number of existing government, nonprofit and private services.

• **Increased federal support** of scientific journals and abstracting services, now done to a small degree by scientific offices in the services.

Volume of literature has doubled each 10 to 15 years since 1800, Wooster says. Example of the problem that results: A survey of 100,000 scientific papers showed that about a fourth were abstracted an average of 2.5 times each, another fourth once each, and about half were never abstracted at all.

PROTOTYPES demonstrated to agricultural pilots include duster (left) with dispenser under fuselage and sprayer with underwing nozzles. All-metal fuselages have removable panels to allow maintenance men to clean internal structures of chemical infiltration.

Grumman Biplanes Probe Spray Market

By Craig Lewis

Dallas—New agricultural airplane designed specifically for aerial dusting and spraying has been demonstrated widely to aerial applicators in the South by Grumman Aircraft Engineering Corp.

Two prototypes of the Grumman biplane were demonstrated to operators in Arkansas, Mississippi, Louisiana and Texas during a tour that started early in October and wound up at the National Aviation Trades Assn. Convention here.

Grumman's new biplane is aimed at a market now largely equipped with a variety of used aircraft, many of them ill-adapted to crop spraying and dusting. Grumman surveyed this market in the summer of 1956 and decided to build the prototypes. Northrop Aircraft Corp. is also reported interested in this market.

Prototypes were built (AW June 24, p. 29) with the intention of using them purely as market research vehicles to get first hand information from the field as to whether they are practical in design and price and whether a sufficient market potential exists to justify putting them into production.

Grumman management, interested in widening the company's aircraft base to lessen the shocks of U. S. military "peak and valley" procurement programs, is studying all angles of civil aircraft market. It already is working on a twin-turboprop-powered business transport, the Gulfstream. The crop dusters present trial balloons as to prospects in their particular field. Management has approved production and sales programs on the Gulfstream, but definitely has not yet committed the company to the agricultural airplanes. Indications are, that as testbeds, their design has not yet been made final.

No definite production plans have been announced for the aircraft, but the company figures it would take about a year to roll out the first production model once work got under way on a production facility.

Two Prototypes

Grumman has built two prototypes of the new airplane, one for dusting and the second for spraying. Both are adaptions of the same basic aircraft, a biplane powered by a 220 hp. Continental engine and designed to carry a 1,000 lb. payload. No price is quoted, but the airplane will probably be in the $17,-18,000 range.

Wing span is 35 ft. 8 in., length 24 ft. 4 in., maximum height 10 ft. 9 in. The biplane gross weight is 3,500 lb.; empty weight is 2,079 lb. Hopper volume is 29 cu. ft. (217 gal.) and the hopper load restriction is 1,000 lb.

New airplane is in experimental status now, but it will be certificated under Part 8 of the Civil Air Regulations.

Grumman rates maximum speed at 115 mph. and stall speed at 38 mph. The aircraft will take off in 310 ft. weighing 2,500 lb. or in 610 ft. at its 3,500 lb. gross weight. Rate of climb is 1,010 fpm. at 2,500 lb. and 540 fpm. at 3,500 lb.

Endurance is rated at three hours with the Continental 220 hp. engine at 1,750 rpm. The airplane can use a variety of engines, including major overhauled surplus, and this is cited as an economy feature. Another economy aspect is lower fuel and overhaul cost on the low power (220 to 300 hp.) engines used.

The new sprayer/duster has all-metal body. One prototype has all-metal wings, the other has wings that are metal on top and fabric underneath. All control surfaces are fabric.

Metal fuselage has removable panels that Grumman says can be taken off in 30 sec. by two men. This feature makes the aircraft interior easily accessible for cleaning.

Fuel tank carries 34 gal. and is in the center section of the upper wing. Upper and lower wing panels are interchangeable, and Grumman says its simple design reduces rigging time. Wings have fixed struts, along with a strut between the dual ailerons. With the torsionally stiff wings, all that is necessary is to bolt them to the center section and fix dihedral with simple rigging.

Describing the virtues of the biplane design, Grumman says it has a low stall speed and a gentle stall. The biplane configuration provides good stall warning, and the two wings provide plenty of crushable structure to absorb energy in a crash. They also provide protection against wires in low level operations.

SPRAY VERSION of Grumman agricultural plane testbed lands at Red Bird Airport, Dallas, Tex. High headrest incorporates overturn structure to protect pilot in crash. These exclusive Aviation Week photos were made during demonstration flights on market survey tour.

Biplane also has a shorter wing span than other configurations might.

Grumman also notes that the sloping nose and the normal flight altitude with the pilot sitting high provide good visibility. One pilot estimates that the ground can be seen 60 ft. in front of the airplane.

The new airplane has spring steel type landing gear. This feature, plus aileron control on the ground, reduces danger of ground looping.

Prominent safety feature in the design is a large headrest rising behind the cockpit. The headrest has an overturn structure in it for crash protection. The structure is a steel tripod which is an extension of the basic structure, and it has a 6 in. x 10 in. dural pad on it. It is designed to keep the pilot from getting "cleaned off" in overturn crash situation.

The cockpit seat, shoulder harness and overturn structure in the Grumman biplane are stressed for 40Gs.

Hopper Location

The hopper and all equipment are forward of the pilot in the new airplane, and the hopper is removable without disturbing wing rigging. A full throat dump valve can empty the hopper in minimum time. The same hopper is used for both spraying and dusting, and only the external gear varies for the different jobs.

Grumman says aerial applicators would be able to choose between buried leading edge spray booms or exposed trailing edge booms. Conversion of the airplane between dusting and spraying gear is estimated at two to three man hours. Small propeller drives hung outside the fuselage power the hopper equipment, act as a pump for the spraying gear or an agitator for the dusting spreader.

Three instruments have been mounted outside the cockpit on the prototypes, although Grumman hasn't decided from operator reaction whether this feature would be on the production model or not. Airspeed indicator and tachometer are mounted in front of the hopper door, which is in front of the cockpit. Fuel gage is mounted below the fuel tank under the center section of the upper wing. Purpose of this outside location is to enable the pilot to check these often-used instruments without having to glance down into the cockpit.

To protect the aircraft from corrosion, all surfaces are coated with Furan base resin paint. This paint is recommended by Texas A & M College, which has done extensive research work in the field of crop dusting and spraying.

WADC Takes Action On Data Link Studies

Dayton—First step toward the long-awaited development of a data link suitable for civil-military use in routine air-ground communications has been taken by Air Force's Wright Air Development Center. The center expects to award between eight and a dozen four-month study contracts for evaluation of a variety of different data link techniques to determine their suitability and economic feasibility for a common system air traffic control signaling system (ATCSS).

Airways Modernization Board is expected to assume program sponsorship in the near future. Meanwhile, 20 avionics manufacturers who attended recent briefing here by WADC's Communication and Navigation Laboratory are readying proposals for a Dec. 13 bid-opening date.

Data link techniques which WADC expects to have evaluated in study programs include many developed for military use under security wraps. Some of the techniques to be studied include: time division, frequency division, Tacan-type, narrow-band television, special purpose teletype, beam-coded omnirange and coded beacons, according to a center spokesman.

AMB to Receive Bids For Avionics System

Washington—At least 25 avionics manufacturers or "combines" are expected to submit proposals this week to the Airways Modernization Board for experimental automatic data processing and display system. (AW Sept. 30, p. 29).

Sperry Rand, Radio Corporation of America and Airborne Instruments Laboratory have formed a team to submit a single joint proposal, with Sperry serving as the prime contractor. Philco and Westinghouse reportedly will also submit a joint proposal. Hughes Aircraft Co. and International Business Machines Corp. each are expected to submit individual proposals for the entire job.

Airways Modernization Board official says the agency hopes to pick a winner by mid-December, or by early January at the very latest.

LONG-RANGE radar, developed by Lincoln Laboratory for ballistic missile defense investigations, is now in operation near Boston. Radar employs 84 ft. dia. parabolic reflector.

Long Range Radar Spots Sputniks

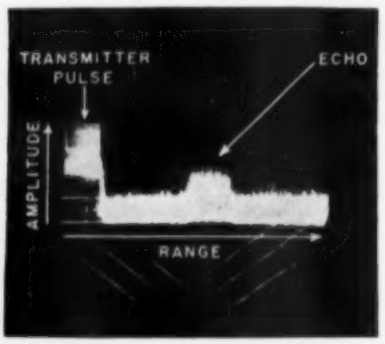
New York—Huge new experimental long-range radar, developed by Lincoln Laboratory to study ballistic missile defense problems, has successfully detected both Soviet earth satellites "at remote distances," it was revealed last week.

New radar, now in operation at Millstone Hill, about 30 mi. north of Boston, reportedly has also tracked Aerobee missiles fired at Ft. Churchill in Canada, approximately 1,200 mi. away.

Millstone radar employs an 84 ft. diameter parabolic reflector which can be rotated 360 deg. in azimuth and elevated from the horizontal to the zenith. Reflector is mounted on a steel tower 90 ft. high. Extremely high power transmissions are made possible by specially designed klystron tubes measuring 11 ft. high.

Special transistorized digital computer, designed and built by Lincoln Laboratory, processes radar return signals on a real-time basis at extremely high speeds to determine target bearing, elevation, range and speed (Doppler frequency). Data is read out automatically on a high-speed printer.

Extremely narrow beamwidth of Millstone radar (estimated at about 2-4 deg.), intended to improve its range and performance against ICBM nose-cone-size targets, has consequent disadvantage of requiring that approximate target location be known in order to correctly orient antenna aiming point.



SPUTNIK I AND II have been detected by new radar "at remote distances."

In early Sputnik sightings, radio direction finding techniques were employed to establish correct aiming point for the Millstone radar. However, the success of infrared radiometers in detecting Soviet satellites with relatively broad fields of view suggest that such devices might be teamed with the Millstone radar to provide such aiming information (AW Nov. 4, p. 31). Small, lightweight radiometer scanning head can quickly search large area whereas the rotating portion of the Millstone radar weighs 90 tons and requires a considerably longer period to scan a similar area.

Lincoln Laboratory says its new radar will also be used to study "radio effects of meteors and the aurora."

Technique Cuts Cost Of Memory Element

New York—Sharply different type of rapid-access computer memory element which is far more simple and less costly to fabricate has been developed by Bell Telephone Laboratories.

Like conventional magnetic core memory array, new technique employs mesh of vertical and horizontal wires. Important difference is that new Bell technique, called "Twistor," eliminates the tiny ferrite cores and with them the difficult problem of threading horizontal and vertical wires through the cores.

Memory array made by the Twistor technique consists of interwoven mesh of horizontal wires made of copper and vertical wires made of magnetic material. Torsion applied to magnetic wires shifts the preferred direction of magnetization from the conventional longitudinal path to a helical path. Coincidence of both circular and longitudinal magnetic fields can then be used to introduce information into this wire in the form of polarized helical magnetization and the magnetic wire itself can be used as the sensing means.

In order to store an information bit it is necessary to apply two simultaneous current pulses, one to the appropriate copper wire, one to the appropriate magnetic wire. Information read-out is achieved by overdriving the longitudinal field in reverse direction and signal is obtained across magnetic wire. Output signal is somewhat larger than input pulse amplitude, Bell says.

Laboratories currently are investigating optimum size and composition of magnetic wires for new memory element. Diameters as small as 0.001 in. appear feasible.

Jet aircraft compressor blade produced by the Aviation Divisions of Kelsey-Hayes.

precision blades for flight propulsion

Superalloy blades, buckets and vanes—*precision components for rotating and static assemblies*—are products of the Aviation Divisions of Kelsey-Hayes. Kelsey-Hayes also produces through its own vacuum melting facilities, the special alloy metals that go into these and other products demanding high tensile strength in the high temperature field. Kelsey-Hayes Company, General Offices: Detroit 32, Michigan.

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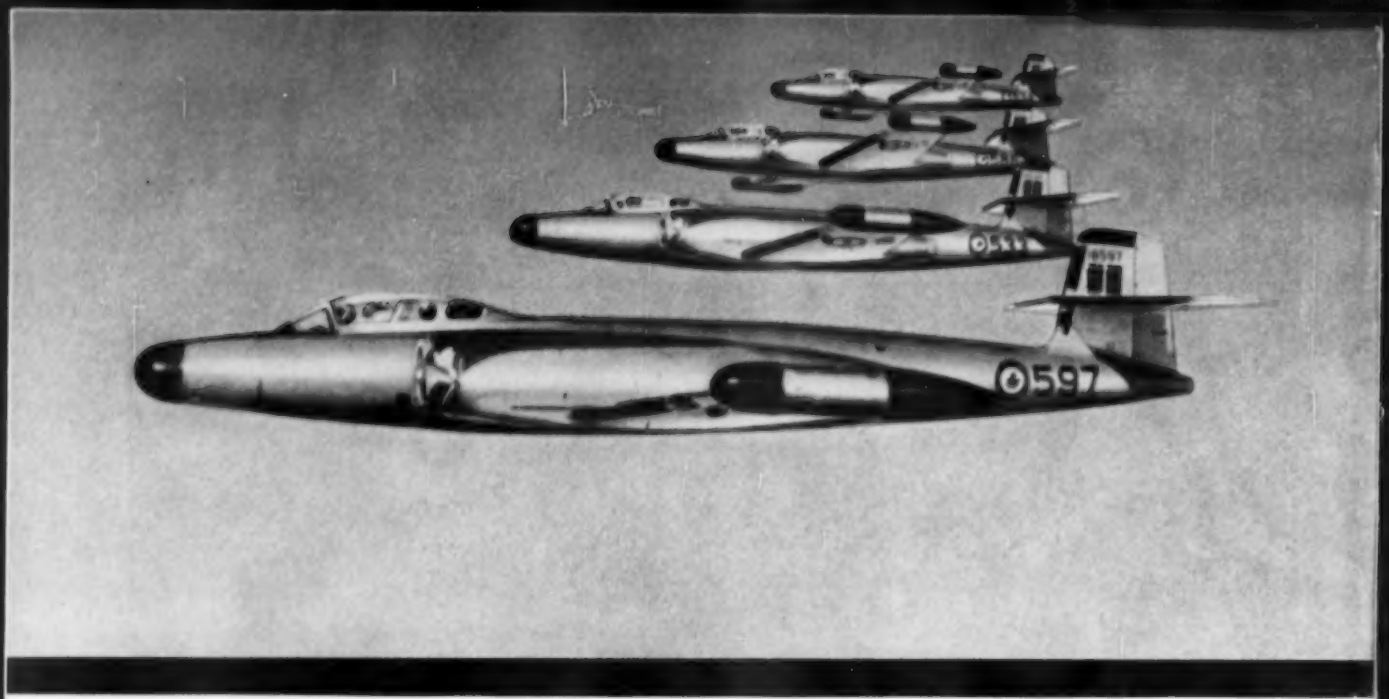
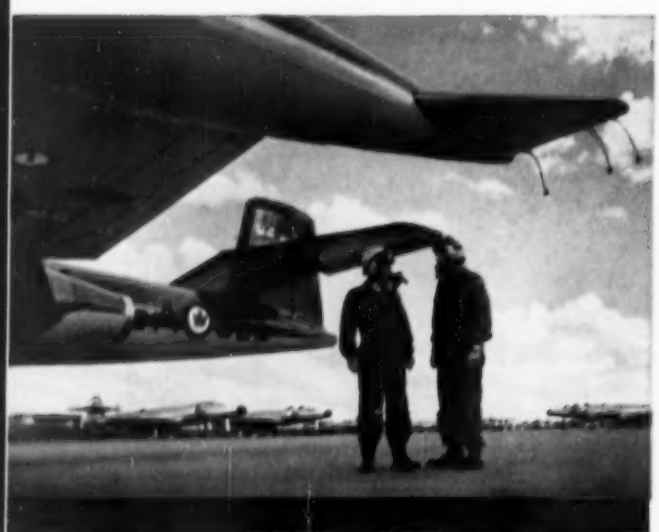


ON GUARD IN CANADA...IN EUROPE...

AND FOR THE FUTURE...THE AVRO ARROW



From the first flight of the Mark I CF-100 in 1950, the development and performance of this all-weather interceptor for the Royal Canadian Air Force has won for it the role of front line defender in North America and Western Europe.

The Avro Arrow, recently unveiled, begins an intensive pre-flight testing program. Under development for the interception role of the RCAF in the new North American Defence Command, the Arrow will have supersonic mission capabilities.

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Congress Ready to Vote Funds For Priority Items, to Cut Others

Washington—Congress appears to be willing to vote funds for the Fiscal 1959 budget required for high-priority defense programs, but there will be strong pressure to postpone or abandon low-priority military and civilian programs.

Commenting on the U.S. missile lag last week, Rep. George Mahon (D.-Tex.), chairman of the House Appropriations Subcommittee on Armed Services, said:

"The prime need is not a spending spree but better decisions and better planning. We are not going to mount a charger and ride off in all directions, but we do want to mount a charger and ride."

A determined effort will be to give top priority to construction of a large nuclear-powered submarine offensive force armed with Polaris fleet ballistic missiles.

Sen. Henry Jackson (D.-Wash.), chairman of the Joint Atomic Energy Military Applications Subcommittee, has called for prompt initiation of a program for at least 100 submarines to be constructed by the time Polaris missiles become operational. He recommended that the submarine force be placed directly under the command of the Joint Chiefs of Staff.

Opposes Carriers

Jackson said he would oppose "any more big carriers," and wanted the submarine construction program to have a separate budget so that it would not be hampered by competing ship programs. "The best use that can be made of ballistic missiles is aboard atomic powered submarines that can fire missiles 1,500 miles from deep under the high seas."

He said the missile-carrying submarines would "present to the Soviets an almost impossible dilemma. They would have to spend billions of their resources to find an answer to this deterrent. It is in this area that we must now push. . . ."

Jackson objected to Navy's present plan under which the first Polaris-equipped atomic submarine would not be ready until 1962, adding "this is the kind of lag time we can't afford."

So far as the overall defense problem is concerned, Jackson said: "Administrative overhauling is the first order of business."

Sen. Clifford Case (R.-N. J.) commented that, "Clearly, we have to make a greater effort to maintain our national defense strength. The American people will not begrudge the money. But . . . they have every right to expect that their tax dollars will be utilized with maximum effectiveness. . ."

Today, the Senate Preparedness Subcommittee, headed by Sen. Lyndon Johnson (D.-Tex.), Senate Majority leader, is scheduled to begin hearings in a comprehensive investigation of the satellite and missile fields (AW Nov. 11, p. 31).

Missile Visits

Last week, Mahon's subcommittee, which passes on defense funds, held an executive briefing session with Secretary of Defense Neil McElroy. Later the subcommittee, which already has visited California missile installations and plants, planned to go to Army's Redstone Arsenal at Huntsville, Ala., and USAF's Patrick AFB, Fla.

Other recommendations made by Jackson on the U.S. defense program include:

- **Take the calculated risk** of paralleling missile production with development.
- **Start now "designing** and planning the best possible launching platforms on land, on the sea and under the sea."
- **"Vastly" accelerate** defense analysis program to assure the best possible operational application of weapons.

Germans Show Interest In Northrop's N-156

Bonn—West Germany is seeking a next-generation interceptor to eventually replace current aircraft. A strong contender at the moment is the N-156, a Northrop Aircraft development of the T-38 supersonic trainer.

Chief selling points, Germans say, are its ability to operate from an unimproved field, fast rate of climb, high altitude and speed performance. In addition it is said to possess versatility to make it usable in various configurations as a trainer, interceptor, fighter-bomber and strike aircraft.

Several other aircraft, including the Grumman F11F-1F, the British Saunders Roe P. 177, the English Electric P.1B, the French Mirage 3A and the French Trident are also in the running.

The decision may be partially political, insofar as there is feeling that the combination of building German foreign currency reserves and the sagging condition of French and British aviation industry should be used to help balance each other.

In any case, there is an unwillingness on Germany's part to use anybody else's leftover equipment.

The N-156 would be ready for delivery by the time present Korean war vintage aircraft now being used or ordered by the German air force begin phasing out.

News Digest

Hamilton Standard propellers will be used by USAF on Lockheed C-130B Hercules turboprop. Company met all technical qualifications and was low bidder in a competition between Hamilton Standard, Curtiss-Wright and Aeroproducts. Production models of the C-130A are equipped with Aeroproducts propellers.

A. V. Roe, Bristol Aircraft, de Havilland Aircraft, Handley Page, Rolls-Royce, Short Brothers and Harland and Vickers Armstrongs have complete preliminary theoretical work on a British supersonic airliner. Companies are working with the Royal Aircraft Establishment at Farnborough. Large part of the main experimental work has been planned, and design and manufacture of research models has begun.

Vertol Model 105 helicopter fitted with two Lycoming T53B turbine engines made first flight last week at Morton, Pa. Speed of the Model 105, a modified H-21, is increased 50% by the installation. Vertol has been flying an H-21 with two General Electric T58 turbines (AW Oct. 14, p. 30).

Convair B-58 Hustler bomber is subject of ground training courses being given by company at Convair-Ft. Worth to about 220 USAF pilots, observers and ground force technicians. Courses embrace the basic B-58 aircraft and its systems, including observer ground checkout. Personnel were drawn from Air Research and Development Command, Air Materiel Command, Strategic Air Command and Air Training Command.

Fairchild Engine and Airplane Corp. reported earnings of $588,000 on sales of $118,693,000 for the first three quarters of the year. These earnings compare with $1,374,000 on sales of $107,455,000 for the first three quarters of 1956. The company has a backlog of $177,000,000.

General Dynamics Corp.'s consolidated net sales for the first nine months of 1957 were $1,133,182,305 compared to $715,505,688 for the corresponding period in 1956. Net income after taxes was $32,089,954 compared to $23,015,606 for the same period last year.

Airlines Face Traffic-Jammed Winter

Increased volume of instrument traffic saturates airways; airline performance may hit new low.

By L. L. Doty

Washington—Increasing volume of instrument traffic, already saturating acceptance rates of major airports and outdistancing the Civil Aeronautics Administration's crash program for airways improvement, is threatening the airlines with another winter of widespread traffic bottlenecks.

A few airline officials fear that the problem of overtaxed airways and airports will become more severe during the next four months than ever before. They expect delays and flight cancellations to force airline performance factors to a new low, resulting in deeper cuts into airline gross revenues.

Airways Plan

Last year, Capital Airlines listed "unusually poor flying weather" and the resultant traffic snarls as one of the three major causes of its net loss for the year. This year, the situation also will have a serious effect on military operations which have grown from 27% of total fixed postings in the U. S. in Fiscal 1950 to 42% last year.

The problem underscores the urgency of the CAA six-year plan for federal airways improvement (AW April 22, p. 26). Although the agency has held close to the accelerated schedule it set for itself last spring, the program has not kept pace with the rising traffic demand which, in Fiscal 1957, caused a 47% increase in instrument approaches over the previous year.

Airlines generally agree that the CAA program has progressed at a satisfactory rate in view of the funds and facilities that have been made available. They point to the unprecedented rise in IFR traffic levels as an indication that system capacity has been expanded to a large degree.

CAA, however, admits the system is overcrowded and that operators can "use more and more capacity, especially in the air traffic hubs."

Traffic at the three key terminals in the "golden triangle" area, Washington, New York and Chicago, already has reached a peak. This means that a chain-reaction of backlogged traffic is inevitable whenever abnormal conditions cause a breakdown in traffic flow.

Washington National Airport is presently handling 639 airline carrier operations during a 24 hr. period and approximately 200 civil and military aircraft movements in the same period. Under VFR conditions, the tower is capable of handling between 60 and 70 movements per hour and between 50 and 60 movements per hour under IFR conditions.

Since the long-range radar at the Washington air route traffic control center is not equipped with circular polarization, heavy precipitation renders the radar useless and the center is forced to revert to time separation of aircraft. As a result, traffic flow is automatically reduced to 25 to 30 movements per hour.

During a 24 hr. period, air carrier movements scheduled at Washington National Airport range as high as 49 per hour. In eight other hourly periods, total airline movements reach more than 35 movements per hour.

As a consequence, airlines can be assured of traffic delays that will backup through an entire airline system whenever conditions reduce operations to a level lower than the IFR norm.

VFR Jams

Often backlogs can occur during reported VFR conditions. For example, on Nov. 1—with visibility ranging between two and one-half and five miles, light rain and fog and ceilings broken at 1,600 ft.—three military aircraft were lost in the area between 1 P.M. and 5 P.M. as a result of either radio or navigational trouble.

A traffic backlog resulted immediately, causing delays of up to two hours. Normal operations were not restored until midnight. The problem was compounded by high winds aloft—up to 45 mph.—and by the fact that weather within a three-mile periphery of the airport was reported by pilots as two miles visibility with a 900 ft. overcast ceiling. Radar was in use, but precipitation reduced the efficiency of radar control, and aircraft separation was increased as a precautionary measure.

LaGuardia Airport in New York handles approximately 567 air carrier movements in a 24 hr. period and about 105 itinerant movements in the same time. During VFR periods, the airport will accommodate 60-65 movements per hour and 40-50 movements per hour under IFR conditions. The New York center, which handled a total of 2.9 million fix postings in Fiscal 1957—the largest volume handled by any center—is equipped with a 13 FPS-8 long-range radar.

Circular polarization can be adapted to the radar equipment, but this has not yet been done, and traffic flow can be cut to between 25 and 30 movements per hour whenever heavy precipitation prevails. The two cases emphasize the need for long-range radar equipment that will serve under all types of weather conditions. The CAA's six-year program calls for a total of 73 long-range radars by 1962. A total of 10 is scheduled for fiscal 1958. At present, Washington, New York, Norfolk and Chicago centers are equipped with long-range radar.

Midway vs. O'Hare

Chicago Midway Airport has reached an absolute peak and controllers claim that traffic would virtually come to a standstill with the addition of one or more scheduled flights. The main problem stems from the reluctance of airlines to move a larger share of their operations to O'Hare Field because of poor surface transportation facilities. Airlines have experienced a drop in load factor as high as 30 points on flights moved to O'Hare.

Nevertheless, the airlines have agreed to review schedules with a view toward shifting more flights from Midway to O'Hare. The City of Chicago, which was represented at a recent meeting, promised to study possible physical airport improvements that will permit more extensive use of dual runways. CAA will review operational problems in hopes of increasing the potential number of takeoffs and approaches that can be handled at Midway.

Out of the 21 international, domestic and local service carriers serving Chicago, only 12 operate any services into O'Hare. Continental Air Lines uses only Midway. Delta operates 16 flights into Midway and one flight into O'Hare. Eastern operates 25 flights from Midway including its Golden Falcon flights to Miami and only three flights into O'Hare, none of which operate as far south as Florida.

Last week, Civil Aeronautics Administrator James Pyle invited airline presidents to Washington to discuss the deepening problem of Midway's overcrowded condition. No immediate solution is likely, however, until a service

MILITARY operations have grown from 27% of total fixed postings in the U. S. in Fiscal 1950 to 42% last year. Increase underscores urgency of plan for airways improvement.

pattern that will provide frequency of flights and direct connections is established at O'Hare.

Although Chicago Helicopter Airways operates regularly scheduled flights over the triangular route between Midway, O'Hare and the Chicago Loop, surface connections between O'Hare and Midway and O'Hare and the Loop are poor. The City of Chicago is constructing an express highway that will connect O'Hare with the downtown section, but the project will not be completed for several years.

What Airways Need

In addition to more long-range radar facilities, here is what is needed immediately if system capacity is to be expanded during the next few years:

• **Peripheral communications:** Airlines and the CAA know that the aim of controlling all airspace above 15,000 ft. by Apr. 1 cannot be realized unless direct pilot-controller communications are established. CAA has installed 375 such communications channels and about 14,000 mi. of new interphone circuits to handle this need. The radiotelephone service will be a major contribution to expediting traffic flow control, but more facilities will be needed as operational deficiencies develop.

• **Radar beacon system:** Secondary radar is needed to add efficiency to radar control through identification of aircraft. The radar beacon is still in the developmental stage, and CAA doesn't expect to have the planned 188 beacons installed before 1962.

• **Air route traffic control** center housing. Present facilities for controllers at hub centers are overcrowded and inadequate for handling modern operating procedures. CAA has made arrangements with the General Services Administration to negotiate leases for new center buildings constructed to CAA specifications.

• **Visual omni ranges.** The Vortac program has been given top priority by the CAA and funds for installation of the units—$255 million—account for almost one-third of total facilities required by the six year program.

• **ILS.** Airlines are awaiting installation of twin ILS units at major airports. A south wind at either LaGuardia or Washington National causing aircraft to approach from the north automatically raises landing limits from 200 ft. to 400 ft. ILS units located at both ends of a runway will permit instrument approaches at the lowest possible limits regardless of wind direction.

• **Controller experience level.** About two years of experience in towers and centers is required before a controller is fully qualified to perform jobs efficiently. Experience level of controllers is now about 40%. In Fiscal 1957, CAA recruited and trained about 1,400 new personnel. An additional 800 controllers were recruited and given on-the-job training at centers and towers. Some 3,000 personnel received advance ATC training at field facilities. Controllers, through the Air Traffic Controllers Assn., are seeking to increase the professional status of their jobs in hopes of increasing their pay-scale. This, they say, will halt the exodus of controllers to better paying jobs and attract more recruits to fill positions created by the expanding traffic.

Traffic Increase

Best indication that the traffic ceiling at Chicago Midway has been hit is shown by these figures: The Midway tower handled 322,408 operations in Fiscal 1957 as compared with 322,496 in Fiscal 1956. The overflow traffic was forced into O'Hare with air carrier operations climbing from 24,202 in Fiscal 1956 to 44,414 last year.

CAA tower operations throughout the U. S. showed a 16% increase in Fiscal 1957. This was twice the 1956 rate of increase over Fiscal 1955.

Airports that have not reached peak capacity showed the biggest increases during the year. For example, Dallas, ranking fourth in total operations, reported a 35% increase in aircraft operations and Albuquerque, ranking sixth, experienced a 32% increase.

Fixed postings for Fiscal 1957 totaled 27,987,000, an increase of 22% over the previous year. Largest gain was reported by the Cleveland center with a 29% greater number of fix postings than during Fiscal 1956.

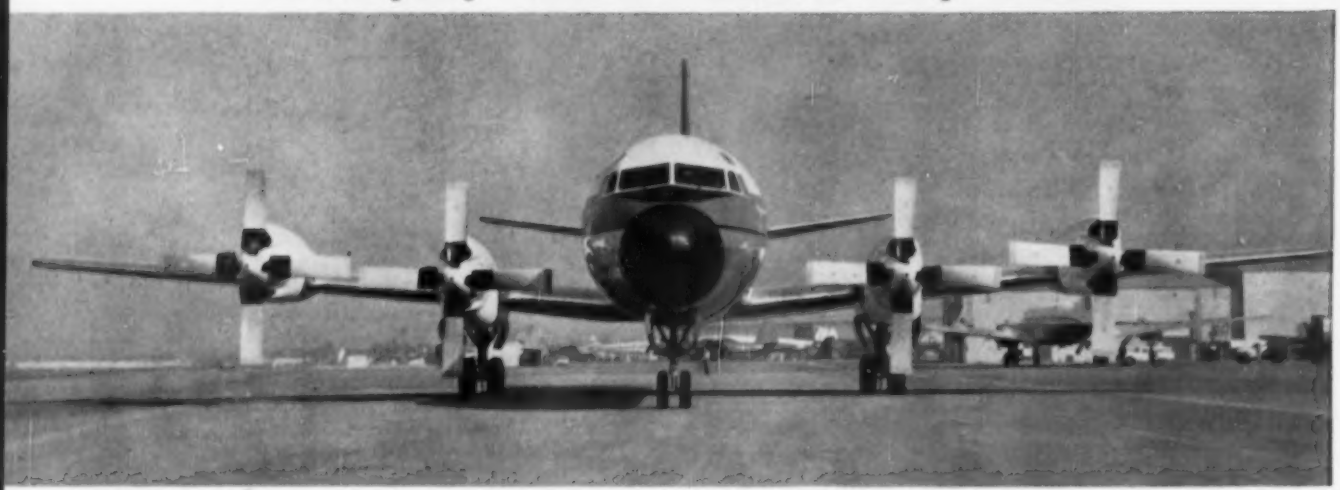
Backlog Cost

Traffic backlogs inevitably begin their build-ups at large air hubs. The far-reaching effects slow down overall operations but more passengers are inconvenienced at the source of the trouble than elsewhere. Large traffic hubs—metropolitan areas generating more than 407,000 passengers annually—account for more than 66% of all passengers and 38% of all departures.

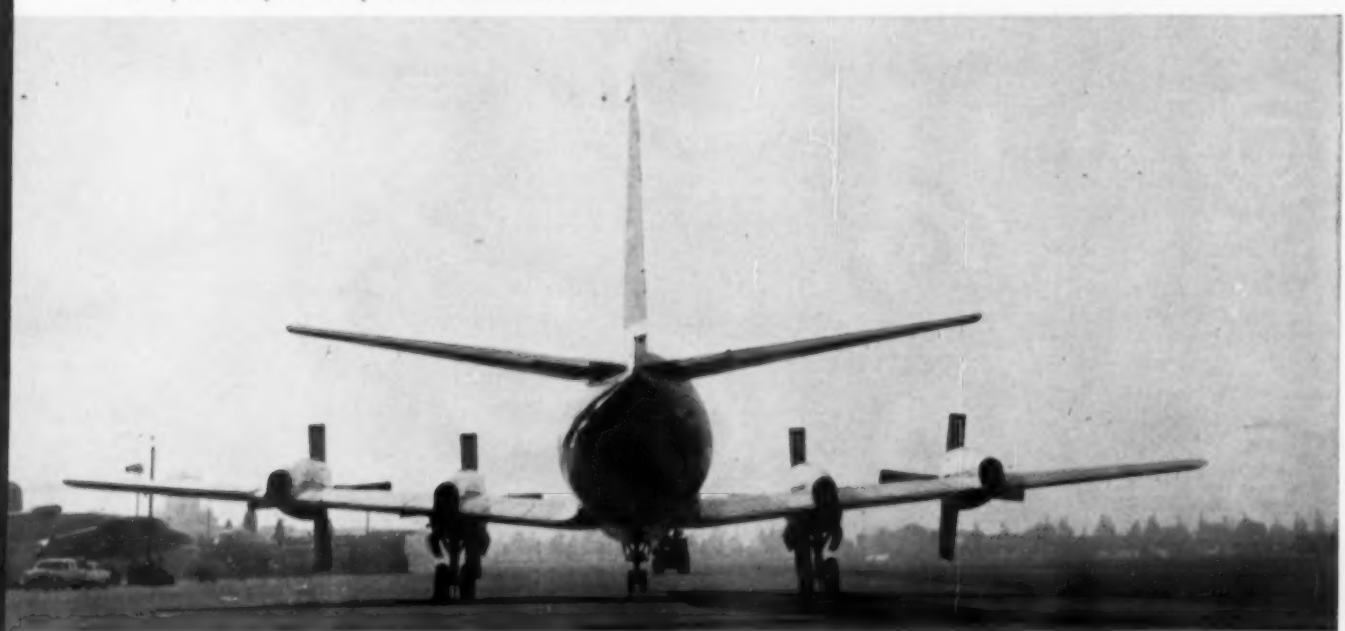
Transports operating out of New York average 27 passengers per plane, 25 passengers per plane at Chicago and 19 passengers per plane at Washington. Revenue losses to airlines mount considerably over an extended period of disrupted operations at any of the key terminal points in this triangle.

In addition, the growth in load factors during the past nine years places more importance upon the efficient operation of each flight in order to gain maximum revenue returns.

Turboprop Electra Makes Early Debut



ROLLOUT of first Electra, a month ahead of schedule, took place Nov. 11 at Burbank plant of Lockheed Aircraft Co. The turboprop airliner went into production in May, 1956. Intensive proving program is scheduled for initial four Electras with goal of Civil Aeronautics Administration certification by next Sept. 30. A picture of Comet IV fuselage in Nov. 18 issue of Aviation Week was inadvertently used in place of a picture of the Electra rollout.



Major Route Awarded Trans Caribbean

Washington—Trans Caribbean Airways, a supplemental carrier, has White House approval to conduct scheduled operations between New York and Puerto Rico. It is the first time a supplemental carrier has been awarded a major long-haul passenger route in the scheduled field.

Pan American World Airways, now operating between New York and San Juan and Miami and San Juan, also was authorized to add Boston, Philadelphia, Baltimore and Washington as co-terminals on its New York, Newark and San Juan route.

Other recommendations made by the Civil Aeronautics Board and approved by the President are:

- **Eastern Air Lines'** temporary authority to operate between New York, Newark and San Juan will be made permanent.
- **Eastern's Miami to San Juan route** should not be suspended but become an intermediate point on three routes, permitting the airline to conduct direct or nonstop service to a majority of the large cities in the eastern section of the U. S.
- **Renewal of Riddle's** all-cargo route between New York, Newark, Miami and Puerto Rico on a temporary basis will be reviewed when the airline's temporary domestic all-cargo certificate is considered.
- **Pan American's** request for authority to route cargo flights between New York and San Juan via Miami is denied.

The recommendations approved by the President were similar to those made earlier by CAB Chief Examiner Francis W. Brown. Previously, bureau counsel had recommended that Capital Airlines operate between Philadelphia, Baltimore and Washington and San Juan instead of Pan American.

Two Exceptions

The Board took two exceptions to the examiner's recommendation—the duration of Trans Caribbean's authorization, and the question of authorizing Riddle to carry non-subsidy mail.

The CAB said Trans Caribbean should be granted operating rights for five years instead of three to permit full development of the route. A shorter period, the Board said, would not permit a fair test of the carrier's ability to conduct the operation.

As for Riddle's request to carry mail on a non-subsidy basis over its overseas all-cargo route, the Board decided to defer action until renewal applications for domestic authority are reviewed.

Major reasons for naming Trans Caribbean for scheduled operations between New York and San Juan was the airline's proposal to inaugurate low-rate "Sky-Bus" fare of $45 between the two points and its impressive record in the market on a supplemental basis.

The Board turned down Capital and National Airlines applications for the New York-Puerto Rico route on the grounds that "it is doubtful that provision of the required low-fare service would yield the additional traffic and revenue support the carriers allege they need and because the award would require a 1,600 mi. route extension into a market where they have no identity."

The Board said it denied Riddle's application to conduct passenger operations because of the desirability of maintaining the airline as an exclusive all-cargo carrier. It said United States Overseas Airlines' application was denied on the basis that Trans Caribbean's record in the market was more impressive.

Eastern's Service

While the CAB found a need for service between Puerto Rico and interior points in the U. S., it said it felt amending Eastern's Miami-San Juan certificate would suffice.

By making Miami an intermediate point on three of Eastern's routes, the airline can provide single-plane service between Chicago-Atlanta-San Juan, Chicago-Louisville-Atlanta-Jacksonville-San Juan and Detroit-Cleveland-Charlotte-San Juan in addition to flights from interior points such as Chicago, St. Louis and Detroit with a stop at Miami.

Delta Air Lines' application to serve the Chicago-San Juan market was denied the CAB said, because of insufficient traffic to certificate another carrier at this time.

Board Member Louis J. Hector concurred with the majority decision but took exception in one respect. He said he agreed with the choice of Trans Caribbean to operate the passenger route between New York and San Juan but differed from the majority in its conclusion. He said:

"I do not find it necessary to conclude that Riddle should remain forever an all-cargo carrier in order to deny its application herein. To my mind, the future of the "all cargo" carriers is an important and difficult problem which requires careful continuing study. The desirability of maintaining this company as an exclusive all-cargo carrier represents a broad, sweeping conclusion not supported by the evidence."

Vice Chairman Chan Gurney disagreed with the majority on two issues. He opposed the certification of a third carrier on the New York route and favored the selection of Delta for Chicago nonstop authority.

"The addition of a third carrier on the New York-San Juan route will do little to improve the service in this area," he said. "The existing carriers have provided increasingly better service through the years as the traffic increased and have added the most modern aircraft on this route as they become available.

As for the other issue, Gurney said it has been the Board's policy in several cases to improve the route structure of the smaller trunks to strengthen them, to make them self-sufficient and thus prevent their reversion to a subsidy status. He said the majority departed from this policy when it failed to reserve the Chicago nonstop route for Delta.

IATA Fare Request Deferred by CAB

Washington—Action on a proposed increase in fares between the U. S. and Havana and Nassau has been deferred by the Civil Aeronautics Board with a view toward eventual disapproval.

The increase was proposed by the International Air Transport Assn. and requires unanimous approval of the governments of all air carriers operating between the specified points.

The resolutions adopted by IATA provided for an increase in first-class fares between Miami and Havana and Miami and Nassau from the current one-way level of $20 to $22.50. The increase would result in corresponding upward adjustments to points beyond Miami in the U. S. and Canada. In addition CAB said the level of tourist-class fares proposed by IATA were identical with that for first class. Also proposed was a special 16-day round-trip excursion fare between Miami and Havana/Nassau during the off-season period between Apr. 15 and Dec. 15 at a level of $36, the same as present first class fares.

The Board said it was unable to approve the proposed fare increases because no showing had been made as to the need. No information in support of either the proposed first-class fare level or the tourist-class level was received from the carriers, the CAB said.

At the same time, the Board said procedural changes with respect to processing IATA agreements appear necessary in the public interest. It said it intended to implement the changes at the time the Board acts on the bulk of the resolutions adopted at the IATA traffic conference in Miami recently.

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Competitive Route Across Canada May Be Outcome of Policy Review

By Glenn Garrison

First airline competition across Canada may result from Canadian Pacific Airlines' plans to apply this month for a mainline route pattern linking Vancouver and Montreal. Canadian Pacific has had its eye on the transcontinental service for some time, but official policy has given government-owned Trans-Canada Air Lines a monopoly on the run since Trans-Canada was founded in 1936.

With a change in government after elections last June, Canadian sources give Canadian Pacific an excellent chance of breaking the monopoly at this time. The new Progressive-Conservative government's pre-election position favored a second transcontinental carrier.

The government has not yet enunciated its post-election policy.

Minister of Transport George Hees is presently reviewing existing policy regarding the licensing of air services in Canada, and has said he hopes to make a statement on the subject during the current session of Parliament.

Competition Urged

Announcing Canadian Pacific's decision to apply for the route this month, Board Chairman W. A. Mather said "we are convinced that the time has come to satisfy the public demand for competitive air service in Canada . . . after 20 years of monopoly, the transcontinental airline now, if ever, should be strong enough to stand up to competition in a prospering economy . . . our application is in line with the proven principles of the free enterprise system."

Mather is also chairman of CPA's parent company, the Canadian Pacific Railroad.

Proposed route pattern, Mather said, would directly duplicate only 10% of Trans-Canada's inter-city services. Canadian Pacific will ask traffic rights at Vancouver, Calgary, Edmonton, Saskatoon, Regina, Winnipeg, Toronto, Ottawa and Montreal. Fifteen DC-6Bs would be available for the domestic service, Mather said.

The airline would serve individual cities in various combinations which actually would provide a pattern of four basic routes.

CPA has been expanding its international network in recent years, including new services to Lisbon and Madrid (AW Apr. 22, p. 42). It has ordered Bristol Britannias, announced no plans to date for purchase of jets. TCA has ordered the Douglas DC-8 as its straight jet equipment.

Canadian Pacific applied four years ago for an all-cargo transcontinental service, a move that was seen as a foot-in-the-door maneuver toward eventual passenger service over the route. The Air Transport Board turned down the application. Back in 1944 the airline asked for a number of short-haul routes that, put together, would have amounted to cross-Canada service. This application met a similar fate.

The airline's timing of its present application is considered excellent. Some observers believed Canadian Pacific would make its move immediately after the election. Instead, it has waited four months. Reason for this, according to Canadian sources, was to avoid introduction of a controversial issue until the government had weathered its first session of parliament, now under way.

With a slim parliamentary majority, the government might have faced a vote of confidence which could have dislodged it. If the Progressive-Conservative faction were unseated, CPA presumably would be right back where it started.

Now, these sources say, the government is firmly ensconced until next spring, for all practical purposes, because Canadian elections are seldom called during the cold winter months. So the government has several months to deal with Canadian Pacific's request.

If Canadian Pacific is awarded the route, there may be strings attached. The airline might be asked to operate some of Trans-Canada's unprofitable segments.

Government a Factor

The Air Transport Board is certain not to act on the application until it is advised of the government's policy. The board's decisions take cognizance of such policy.

Procedurally, CPA's application will be advertised for 30 days throughout Canada after it is received by the board. It will then be determined whether public hearings are needed. If such is the case—and the importance of the matter assures that it will be—the hearings are advertised for a like period and then held at various cities.

If the board then approves the application, it will go to the Minister of Transport for his approval, which will be the final step.

On the international front, Canadian Pacific would like to serve Rome to back up its Lisbon-Madrid route. The carrier also serves Amsterdam via a polar route from Vancouver.

The Lisbon-Madrid service, inaugurated earlier this year, is losing money and extending it to Rome would improve the situation and point toward a world service. However, there is no bilateral agreement between Canada and Italy and none is foreseen in the near future. So Canadian Pacific can't ask the Air Transport Board for something the board hasn't got to give.

A third Canadian airline, Pacific Western, also reportedly is seeking to get into the transcontinental act with service between Vancouver and Windsor, Ontario. Pacific Western wants to fly on to the Caribbean, and is said to plan purchase of three Comet 4Bs if it gets the routes.

Trans-Canada Airlines carried about 281,000 passengers on its transcontinental route pattern during the first nine months of this year. Service between Toronto and Montreal accounted for about 167,000 of the total. Traffic between Toronto and Winnipeg totaled about 35,000 passengers. Other high-density segments included Toronto-Calgary, with about 15,000 passengers, and Toronto-Vancouver, with about 20,000 passengers.

TCA recently announced fare changes to become effective Jan. 1. Tourist rates on transcontinental services between Halifax and Vancouver will go down 10%, putting them 30% below first class fares. Return fare reduction on first class services will be reduced from 10% to 5%.

President G. R. McGregor said the changes will reduce average return for each passenger-mile, but he hopes increased volume will make up for loss.

TCA also plans to make 15 tourist seats available on its Super Constellation service between Montreal, Toronto and Vancouver, presently an all-first-class run.

Comet 3 Noise Tests Arranged for PNYA

London—Noise measurement tests of the de Havilland Comet 3 jet airliner are to be made at the company's Hatfield plant for The Port of New York Authority.

Acoustical consulting firm of Bolt, Berranek and Newman, Cambridge, Mass., will conduct the tests on behalf of The Port Authority. A de Havilland spokesman says the decision to carry out the tests at this time does not indicate any immediate plans for a U.S. sales tour by the Comet.

"It's an obvious hurdle," he reports, "and obviously is something we shall have to do for Capital Airlines and other U. S. airlines interested in the Comet."

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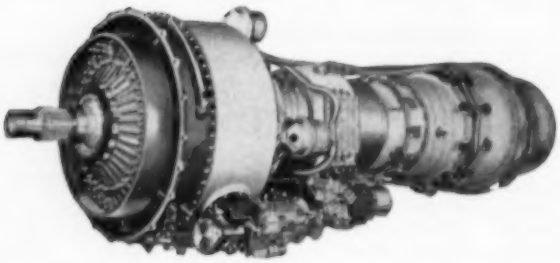

The Tyne is an advanced twin spool high compression engine in the 5,000 h.p. class. It has been designed to give a very low specific fuel consumption and is backed by the unique experience gained by Rolls-Royce in more than 3,000,000 hours airline operation of Dart prop-jets powering Vickers Viscounts.

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American Testimony Opens Fare Probe

By Ford Eastman

Washington—Hearings in the delayed General Passenger Fare Investigation first ordered in May, 1956, opened before the Civil Aeronautics Board Examiner Ralph L. Wiser last week with American Airlines the first of 12 domestic trunklines to take the stand.

American President C. R. Smith headed a long list of witnesses scheduled to present arguments designed to convince the CAB that passenger fares should be increased.

Smith said the airline needs a rate of return on its invested capital, after taxes, of about 12%, and that to attain this, fares should be increased by 15%.

He said the conclusion was based on advice from outside consultants and American's own studies and experience.

American is one of the nation's strongest domestic carriers financially, and its rate of return in the past has exceeded the 12% figure at current fare levels.

Last year its rate of return was 13.5% as revenues and dollar return reached an all-time high.

Shrinking Profits

Smith said, however, that last year also marked the beginning of a downward trend in profits which is discouraging investors from risking their capital in the industry. Instead, he said, they look to other enterprises with more stable earnings in which to invest their money.

Smith noted that American already has ordered 30 Boeing 707 jet transports and 35 Lockheed Electra turboprop transports in an initial step toward meeting the airline's turbine equipment needs up to 1961 (AW Nov. 4, p. 40). To pay for the equipment now on order, American has made arrangements to borrow $135 million from the Metropolitan and Prudential Life Insurance companies on favorable terms.

At the time the loans were negotiated in 1955 and 1956, American said it felt safe in assuming its earnings after fixed charges and taxes would not fall below the $18-$20 million mark.

To complete its turbine equipment program, Smith said American would require 15 long-range and 25 medium-range jetliners in addition to those already on order at an estimated cost of $200 million including the cost of related ground equipment.

"We do not have that money," Smith said. "Our total net worth at the end of 1956 was only $128 million, and it will be very little more as of the end of 1957. At present fare levels, we will suffer a loss in 1958 after payment of interest.

"Our cash flow through 1960—again at present fare levels, and even without deposits on additional equipment orders—would bring us to perilously low points. By the end of 1959, current liabilities will actually exceed current assets, resulting in a negative working capital position."

Smith said the only way American can attract the necessary capital to complete its program is through a reversal of the downward trend and an increase in earnings to a point where airlines can compete with other business for a share of available money.

Attracting Financing

Edwin H. Herzog, a partner of Lazard Freres & Co. investment banking firm and a director of American Airlines, followed Smith to the stand. He said the company required annual earnings of about $25 million in order to attract the necessary financing.

This would not only permit the company to undertake additional borrowing but would place American in a stronger position to raise equity capital as well.

Herzog explained that on the basis of present earnings and forecasts of earnings, the most American could raise in the way of additional capital over and above present commitments would be about $25 million. He said lenders will be most reluctant to commit themselves on a new project when they see that present commitments already are considerably less secure than they were a short time ago.

"To support both the present program and to have any hope for future financing of the additional program," Herzog said, "there must be a restoration not only of the aggregate dollar earnings to the level of a year ago but as well a restoration of the atmosphere existing in the 1955-1956 period."

Airline Stocks

Another witness appearing on American's behalf was Benjamin S. Clark, general partner of White, Weld & Co., investment firm.

Clark's testimony was devoted to an explanation of why airline stocks are not considered attractive for investment purposes in relation to other investment opportunities.

"The broad aspects of the problem are quite clear," Clark said. "Earning power is declining in spite of a strong growth in operations, and the decline is taking place on the very eve of immense capital needs. The net effect of all this has been to destroy the confidence of professional investors in the industry's future. This is shown tangibly by the drop in price of airline stocks."

The hearing is expected to run well into next year and has been divided into three phases.

The first, now under way, concerns the rate of return for airlines, the second will cover the forecast of future operations while the third take up remaining issues.

New Version of 707

Seattle—Boeing plans to offer a new short-to-medium range version of its 707 jet transport similar in size to the 707-80 prototype that has been flying for the last two years. Top speed is scheduled to be over 600 mph.

To make way for the new aircraft, designated the 707-720, Boeing will abandon two earlier but similar designs, the 717 and 727 (AW April 15, p. 38). Wing and tail area and fuselage cross section of the 720 will be approximately the same as that of the 707-80, and much of the aircraft can be manufactured with production tooling already in Boeing's Renton plant.

Gross weight of the aircraft will be between 175,000 lb. and 200,000 lb.

The 720 is scheduled to include late models of the Pratt & Whitney JT3, commercial version of the J57. Some J57 models are now producing 11,500 lb. dry thrust, but Pratt & Whitney expects to boost the dry thrust to above 12,000 lb.

Cargo Line Asks Route to Moscow

Washington—Seaboard and Western Airlines last week applied to the Civil Aeronautics Board for permission to extend its transatlantic all-cargo route to Berlin, Warsaw and Moscow.

The present terminal points of the airline are Hamburg, Munich and Zurich.

At present Pan American World Airways holds a U. S. permit to operate into the Soviet Union. A suggestion earlier this month by the Russian embassy that talks between the U. S. and the Soviet Union be started on a possible bilateral agreement between the two countries has not materialized (AW Nov. 11, p. 41).

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SHORTLINES

► **Allegheny Airlines** has requested Civil Aeronautics Board approval of a reduced fare tariff for members of the clergy. The fare, scheduled to become effective on Dec. 1, would permit clergymen to fly at 50% of Allegheny's present first-class fares.

► **Avianca**, Colombian National Airways, will begin operating 11 flights a week from the U. S. to Colombia on Dec. 1. Nine of the flights will originate at New York International Airport, two at Miami International Airport.

► **Iberia Air Lines of Spain**, General Director Cesar Gomez Lucia says Iberia's future plans include service to Athens, the Scandinavian countries, the Benelux nations, Cairo and an extension of the airline's South American services to include Santiago, Chile and Lima, Peru.

► **Newark Airport** will be serviced by a new $4 million air cargo center, the Port of New York Authority has announced. The center, comprising four single story structures on a 29 acre site, will be operating by the summer of 1959.

► **Pan American World Airways** reports a 17% increase in eastbound Atlantic cargo service during the first nine months of this year over that of the same period of 1956. The airline claims to be carrying 23% of the transatlantic air cargo total.

► **Southern Airways** flew 19,500 passengers 3,580,000 passenger-miles during October. The airline, which recently boarded its one-millionth passenger, reports a 10-month total of 181,400 passengers flown 31,563,000 passenger-miles.

► **Swissair** is offering a 17-day ski tour to the Austrian Alps for $595.00 this winter. The airline also plans a number of similar tours for January, February and March, including 21-day visits in addition to the 17-day excursions to Swiss, Austrian and French mountain resorts.

► **Trans World Airlines** will begin nonstop Lockheed 1649 Constellation service from New York to Frankfurt on Dec. 5 with two flights weekly. On Jan. 1, TWA will begin nonstop flights to Zurich from New York and on Jan. 5 nonstop service between New York and Madrid. This will bring to eight the number of European cities served by nonstop TWA flights.

AIRLINE OBSERVER

► Airlines are beginning to feel the pinch of defense cutbacks (AW Sept. 30, p. 47). Decline in travel by subcontractors has caused West Coast traffic to drop and has been particularly noticeable in Western Air Lines operations between Los Angeles and Seattle. Boeing, with headquarters in Seattle, has advised its people to use coach flights rather than first-class where practicable. Widespread expansion of such a move by the defense industry could cut an even deeper slice into airline revenues.

► **American Airlines is converting 10 of its standard first-class DC-7s into combination configurations and expects to complete the modification by the first of the year. Move is designed to increase flexibility in scheduling aircraft and to expand flight frequency of both tourist and first-class service.**

► Watch for an intensified sales campaign by Douglas Aircraft for its DC-9 medium-range turbojet transport. Douglas wants a new airplane for production at its Santa Monica plant since engineering on the DC-6 and DC-7 series will be complete in three months, and the end of the production line will soon be in sight. No building on the Santa Monica property is large enough to hold the larger DC-8 long-range turbojet transport.

► **Pan American World Airways has been forced to delay inauguration of service on new routes from Puerto Rico to Madrid and from New York to Johannesburg via Madrid because the Spanish government continues to stall in giving the new services its approval. During talks with the U. S. State Department in October, the Spanish government asked for time to study the proposed Madrid stop before granting Pan American its permission to operate the routes. Now many observers are beginning to feel that the stall stems from a fear of too much competition for state-owned Iberia Air Lines of Spain and may continue for some time.**

► United Air Lines will be operating an all-jet fleet by 1965. The plan contemplates the purchase of 92 additional turbine aircraft in addition to 30 DC-8s now on order. The carrier has definitely discarded earlier plans to include turboprop transports in its program. Fleet will consist of 30% long-range equipment, 40% intermediate-range and 30% short-range aircraft. First stage of a $12 million expansion program at the airline's San Francisco base will begin shortly with the construction of a jet engine overhaul base coupled with a 50,000 sq. ft. expansion of present facilities at a cost of $4 million.

► **British government has rejected claims that noise and vibration of a Russian Tu-104 turbojet transport damaged seven homes during takeoff from London Airport on Sept. 8. Residents claimed the aircraft, on a diplomatic mission, caused shattered windows, cracked roof tiles and fallen plaster during a takeoff that created a "great noise and disturbance." The government reported that an independent investigation showed that damages "are of long standing and attributable to causes other than takeoff."**

► Trans World Airlines pilots are accompanying the airline's sales representatives in calling on Kansas City businessmen on a voluntary basis. Purpose of the experimental plan is to help acquaint business travelers with the technical aspects of airline operations.

► **Presidential Assistant Elwood Quesada will begin public hearings Monday on best site for a second Washington airport. Quesada has narrowed the selection to four possible locations—Burke, Chantilly and Pender in neighboring Virginia and Baltimore Friendship Airport.**

► Eastern Air Lines has leased three DC-7s from United Air Lines and six Lockheed Constellations from Trans World Airlines until May, 1958, to handle Florida winter traffic. Eastern will operate the DC-7s in first-class service and the Constellations as 78-passenger aircoaches.

► **Capital Airlines and Shell Oil Co. have renewed their turbine fuel contract for a four-year period. Estimated consumption of the 640 kerosene will run approximately 80 million gallons annually.**

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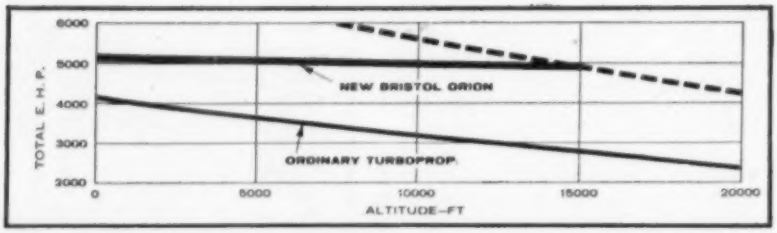
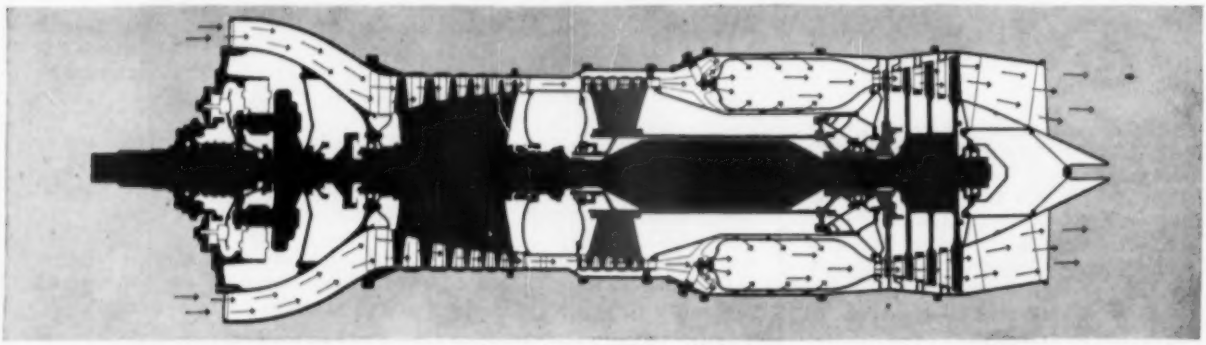
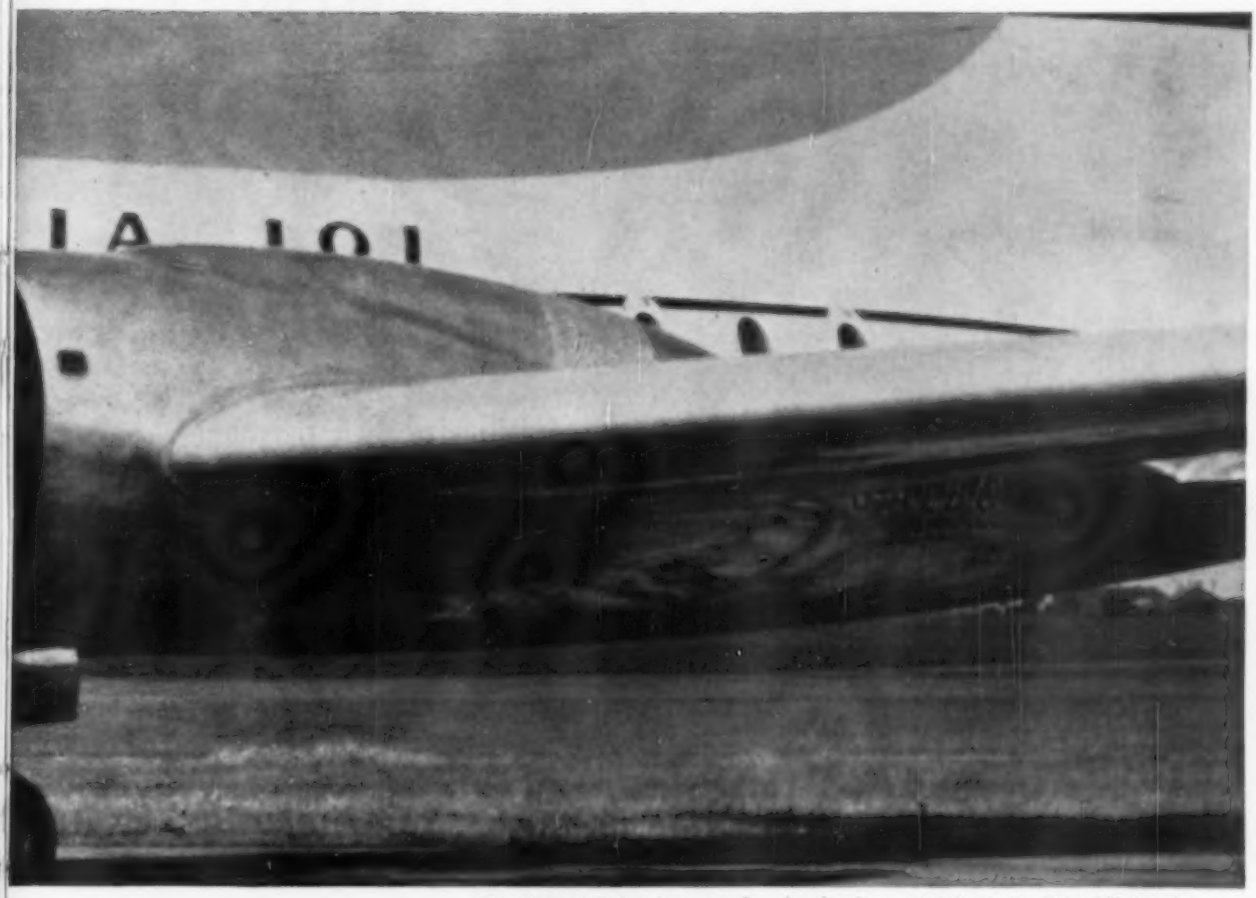
First and only turbine engine to deliver full take-off power at all temperatures, all elevations up to 15,000 feet







The Bristol Orion is now undergoing development-flying in the Bristol Britannia

World's first supercharged turboprop

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Facts on the mighty new Orion

A two-spool constant-power turboprop. Take-off rating, 5,150 ehp.

Orion's twin compressors. Work split between low and high-pressure stages is arranged to allow both stages to run near maximum adiabatic efficiency. The twin-spool layout also leads to unprecedented flexibility of operation.

Advantages of "Gating." Orion is an 8,000-horsepower engine deliberately throttled at sea-level. At 30,000 feet and maximum cruising power it delivers 3,960 ehp. By restricting output to 5,000 hp from sea-level up to 15,000 ft, propeller and reduction gear can be lightened—giving marked reduction in specific weight.

Yet for take-off at high temperatures or elevations, the Orion can be given its head by simply opening the throttle—water-injection and other power-boosters are unnecessary.

Phenomenal Economy. Specific fuel consumption of the Orion is well under 0.40 lb/ehp/hr. This phenomenal economy makes it possible to achieve long-range, low-cost transport of high payloads.

Orion-powered airliners could operate at 550 mph—displaying journey times competitive with pure jets—but at a fraction of the cost.

The famous Bristol engine family. Bristol Aero-Engines Limited also produce the well-tried, economical Proteus turboprop—powering the Bristol Britannia; the high-power, low-consumption Olympus turbojet; the lightweight Orpheus turbojet; the Thor ramjet—in production for the Bloodhound S.A.M. Constant research activity ensures that Bristol will continue to lead in bringing power to the wings of the world.

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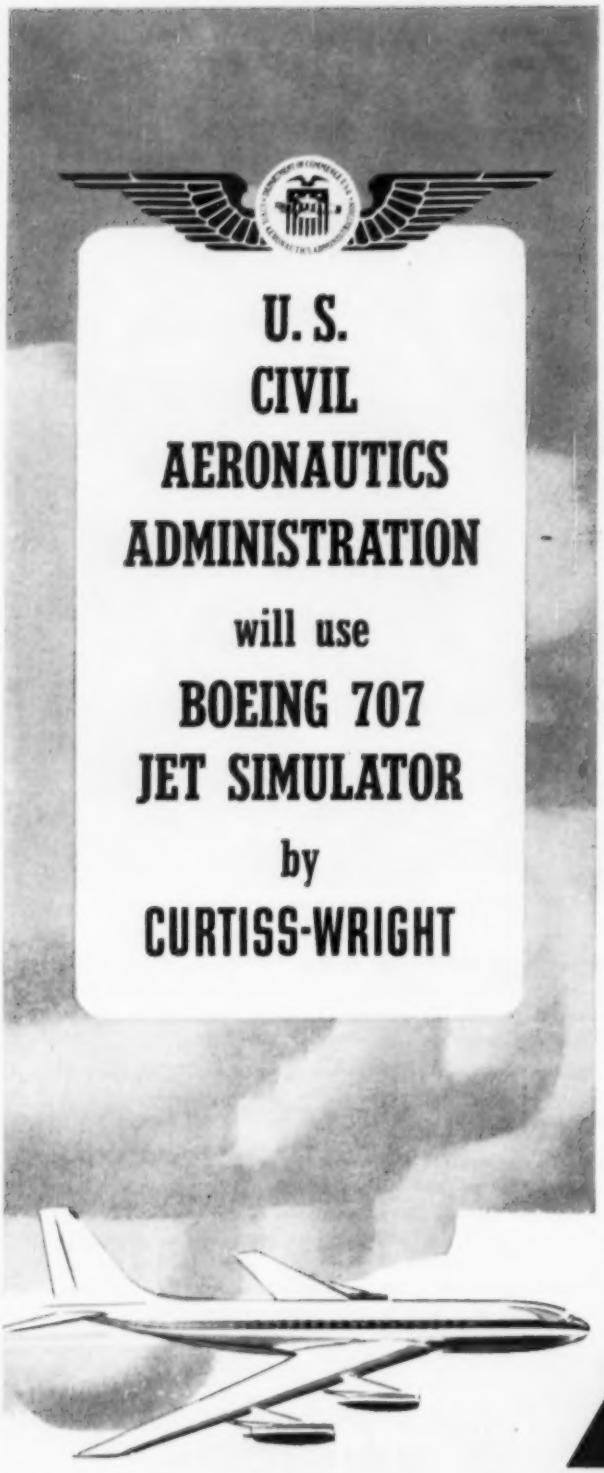

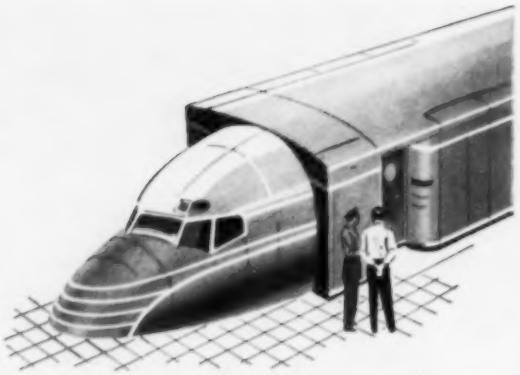

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Playing a leading role in the transition to the jet era, the Civil Aeronautics Administration has selected an electronic jet Simulator to be designed and built by the Electronics Division of Curtiss-Wright Corporation. Among its many missions will be the training and familiarization of CAA air carrier inspection personnel in jet transport operations, including all phases of airline flight crew training . . . and the study of approach and holding procedures for improved air traffic control in the jet era.

At the same time, the CAA will take advantage of another dimension in the realism of flight reproduction — Curtiss-Wright Dehmel Visual Aids Simulation Equipment. This new Curtiss-Wright equipment consists of scale models of specific airports, and a mobile television camera which responds to the pilot's control — enabling him to rehearse landings and take-offs under VFR (Visual Flight Rules) conditions.

The airport environment, buildings and runways are realistically viewed by the pilot, on a large screen, in their true relationship to his altitude, position and approach.

Simulators by Curtiss-Wright have been produced for nearly every type of advanced civil and military aircraft. They have a long background of proven service, including extensive use by the CAA itself. Every fully electronic Simulator used by U. S. airlines today is a product of Curtiss-Wright.

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ORPHEUS 3 turbojet for NATO light fighters is less than 3 ft. dia., slightly more than 6 ft. long. Thrust-weight ratio of the engine is 5.9. Engine has seven compressor stages, a cannular combustion chamber and a single-stage turbine. Dry weight of the engine is 825 lb.

Light Orpheus Jet to Power 11 Designs

By David A. Anderton

Bristol, England—Eleven airplanes in seven countries are being built around the Bristol Orpheus lightweight turbojet developed for the NATO light fighter program.

Under a contract with the joint Mutual Weapons Development Program of the NATO countries, Bristol is developing and building the Orpheus 3 and its successor, the Orpheus 12.

Orpheus 3s powered the Breguet Taon, Dassault Etendard 6 and the Fiat G.91 through the comparative flight test trials at Bretigny last month (AW Oct. 28, p. 50).

The earlier Or. 2 engine is flying in the Folland Gnat and in the Lockheed Jetstar. In Italy, the Aerfer Leone is scheduled to get an Orpheus; in Japan, the Fuji T1F-1 is being designed around the Bristol engine. Spain's Hispano HA-300 delta-winged interceptor and a Yugoslavian project incorporate the Orpheus.

In the United States, North American Aviation, Inc., has specified the engine as an alternate powerplant for its 246 transport and its T2J trainer for the Navy.

Built Under License

The engines will be built in India under license. The French firm of Sneema has a license for an Orpheus development. Fiat-SMA in Italy has an option on a license and Curtiss-Wright in the United States has a license to build the engine as the TJ37.

All this started with engineering perception at Bristol. First, there was the perception of the need; it didn't exist at the time, but some Bristol people thought it would. Second, there was perception of the way to meet the need, in the design of a rugged, lightweight engine that would be suitable for a variety of light fighters.

Bristol's detail design work and the first running of the engine are separated in time by less than a year, which must be some sort of a record for a contemporary turbojet.

Basic rating of the current engine, the Orpheus 3, is 4,850 lb. sea level static thrust. Dry weight of the engine is 825 lb., and the thrust-weight ratio is 5.9.

Engine Description

The Orpheus series of engines is built around a seven-stage axial compressor, a cannular combustion chamber having seven individual flame tubes and a single-stage turbine. It uses about one-third the number of parts in a conventional engine. The overall envelope dimensions of the engines show a max-

CONTROL and accessory package of Orpheus 3 is located on underside of engine at forward end of compressor casing, for easy access in field. Simple maintenance was a design criterion.

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BLANKING—Single impact blow of third Cecostamp accomplishes blanking of instrument holes. Bottom blanking die is made of zinc alloy using ½" thick chrome alloy plate backed by rubber in hole openings to eject slugs. Upper die has ⅜" chrome alloy punches. Rubber, cemented around perimeter strips panel from die. Only ⅛" landing between some of the holes—and approximately 225 lineal inches are sheared!

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Orpheus Engine Specifications

Engine	Orpheus 2	Orpheus 3	Orpheus 4	Orpheus 12
Rated thrust, lb.	4,520	4,850	4,230	6,810
Diameter, in.	32.4	32.4	32.4	32.4
Length, intake face to exhaust flange, in.	73.0	75.45	75.45	80.67
Weight, dry, lb.	790	825	880	1,055
Thrust weight	5.7	5.9	4.8	6.5

imum width of 32.4 in., a maximum height of 36.6 in., and a maximum length of 96.1 in. Nominal diameter of the engine is 32.4 in. and length from the flange of the intake to the flange of the exhaust nozzle is 75.45 in.

The outside diameter of the compressor is constant. The air discharged from the last stage passes through a stator stage into the delivery casing, which is the transition section between the compressor and the combustion chamber housing.

Each of the seven internal flame tubes in the cannular combustion chamber ends in a transition to a sector of stators integral with the can's end.

The single-stage turbine is of conventional layout; its size is increased somewhat in the high-altitude versions of the Orpheus.

Lubrication is by a waste-oil system with about one and one-half pints of oil thrown out during a typical flight. There are two bearings: a roller bearing behind the compressor and a double-race ball bearing ahead of the inlet guide vanes.

Accessory Power Drive

Bevel gears off the main compressor shaft drive a vertical jackshaft to the accessory and control package under the engine.

All blades are precision forged to size; the only machining is done on the blade roots.

Compressor blades, discs and stators are made of light alloys. The intake casing and the compressor casing are made of zirconium-magnesium alloy and the delivery casing is aluminum alloy.

In the hot section, the flame tubes are made of Nimonic 75 and the turbine stators of Nimonic 90. The turbine disc is H46 ferritic stainless steel and the blades are Nimonic 90. Exhaust cone and jet pipe are made of Nimonic 75.

The increased performance expected in the Orpheus 12 development will undoubtedly call for some changed material specifications.

The Orpheus 1 engine was a development engine for ground and flight test work. Twenty-nine of them were built.

Orpheus 2 is the engine for the Folland Gnat. Its drawback is that the fuel pump specified for the airplane was a Lucas Type B which does not supply enough fuel to enable the engine to make its full sea-level static thrust rating. Takeoff thrust for the engine is 4,000 lb. But as the airplane climbs, the engine comes up to its governed rpm., and at altitude is putting out the thrust equivalent to a sea-level rating of 4,850 lb.

Production Version

The Orpheus 2 engine in production carries the designation of Orpheus 700. A development of this engine is the Orpheus 701, for high-altitude applications. The basic Orpheus engine was not intended as an interceptor powerplant, but recent thinking has been along those lines for both the Folland Gnat and other aircraft. Although the basic design points remain the same for both engines, the 701 has better altitude capability than its immediate predecessor and has been flown up to 45,000 ft. in the Folland Gnat.

Developing the engine for altitude performance ran into the usual snags of stall due to the geometry of the powerplant. Small sizes mean small blades and small operating Reynolds numbers, down in the range where stall is more critical and more easily triggered. Early development flying produced flameouts at 40,000 ft., and blowouts by gunfire at operating points below the surge line.

While trying to solve this problem, Bristol engineers also were working on other aerodynamic changes within the engine and quite by accident stumbled upon a flameout fix that resulted from an entirely different fix on a remote part of the engine.

Fuel dipping was incorporated into the high-altitude engines as a result of the experience reported by Rolls-Royce Avon-powered Hawker Hunters. The problem was that gunfire on the Hunter

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USAF Cancels J91

Washington—Air Force has officially announced cancellation of its contract for development of Pratt & Whitney's 25,000 lb. thrust J91 turbojet engine which was scheduled to power an atomic plane.

Plans for cancellation or curtailment of the project had been known for some time, and in August Pratt & Whitney warned its stockholders that the program might be "possibly eliminated entirely" (AW Aug. 19, p. 34).

Air Force said that its contracts with General Electric for a second powerplant and with Convair and Lockheed for airframes for the atomic-plane project were still in force.

blew out the engines, and the basic cause was that the engines were operating too close to the surge line. Gun blast gases, sucked into the engine inlets, increased the ambient air temperatures in effect producing hot-day conditions within the engine. The power dropped but the fuel flow corresponded to a high-power condition. Surging was the result and the engines blew out.

The cure was a simple one. A switch in the gun firing circuit reduced fuel flow just a split-second before the guns fired; with reduced fuel, the engine power curve dropped naturally and the margin between it and the surge line increased. Blowouts stopped. Now the Gnat's guns can be fired right up to 45,000 ft.

Orpheus 2 Controls

Use of the Gnat as an interceptor produced a pair of additional controls for the Orpheus 2. An all-altitude acceleration unit is now being installed on the airplane, and also a pressure-ratio control which keeps the rpm. automatically below the surge line regardless of flight conditions. Acceleration time from flight idle to maximum power at altitude, using the ratio control, is expected to be about four seconds.

NATO's engine is the Orpheus 3, being developed under a contract covering procurement of 60 engines. Originally written to take the Orpheus 3 through its type test, the contract has been extended to cover the development of the engine to the Orpheus 12 including its type test.

Although the specification for the light fighters calls for their use in a ground-support role at mission altitudes below 5,000 ft., the recent tests at Bretigny were conducted under the supposition that successful engine operation would have to be shown at 30,000 ft.

The engine is also required to oper-

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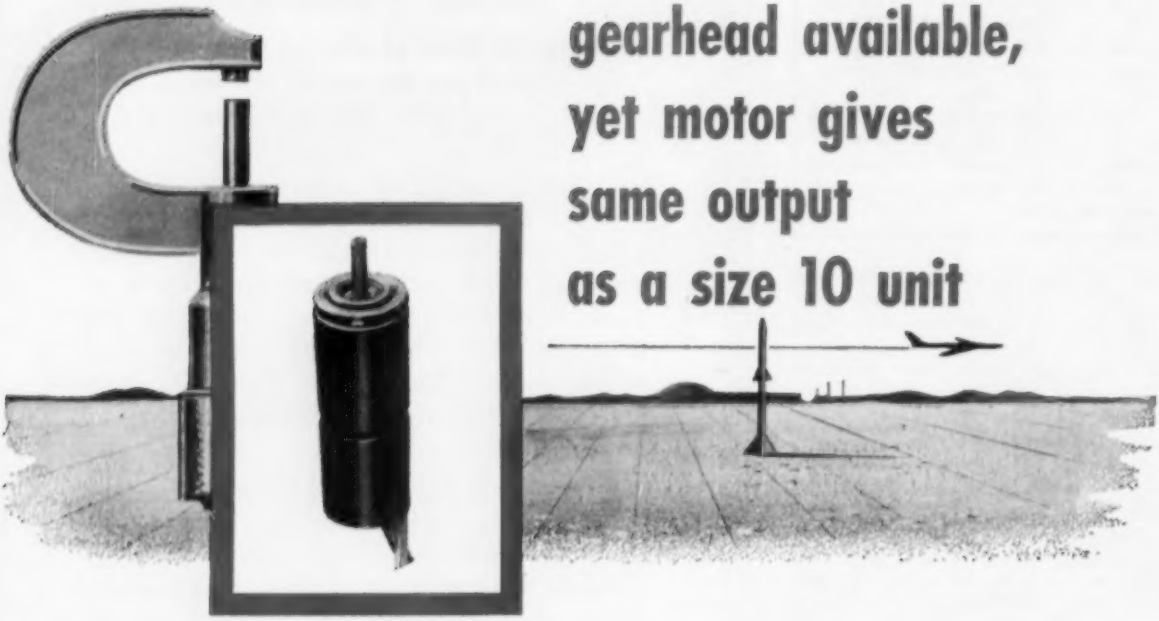

OPERATING CHARACTERISTICS:

- Type of motor: Two phase
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The Edison Instrument Division has met the challenge of greater miniaturization in servo motors for aircraft and missiles. The size 8 Gearhead Motor shown here is a typical example. This particular Edison unit can be supplied in any gear ratio within 2% and has the smallest diameter gearhead now available. Add to this salient feature the fact that this unit gives the same output as a size 10 motor and you have an ideal motor for such miniaturized projects as small panel mounting instrumentation and small computers for aircraft. Its light weight also makes this gearhead motor easily adaptable for missiles work.

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ate for 15 sec. with the airplane in an inverted position.

The Orpheus 3 uses a Lucas Type D fuel pump, but otherwise has accessories built to continental European standards. It develops 4,750 lb. sea level static thrust at 9,900 rpm. Specific fuel consumption is just over unity at its rated thrust.

Derated Version

For trainer applications, the Bristol engineers have designed the Orpheus 4, a derated version of the Orpheus 3. Thrust of the Orpheus 4 is approximately 4,200 lb. The purpose of derating has been to lower the operating temperatures and thereby increase the life of the engine. First talk of the Orpheus 4 considered it as a powerplant for the Gnat two-seater trainer. Since then, the light fighter companies have presented their versions of two-seat trainers for their fighters, all powered by the Orpheus 4.

Designations of the engine skip from Or.4 to Or.11, reported as a development engine for the Or.12. Thrust rating of the Or.11 is 5,760 lb.

The Orpheus 12 is a somewhat different engine. It is longer, heavier and produces 40% more thrust. It has an increased air mass flow. Its thrust rating is 6,800 lb. and with Bristol Sim-

SAC Bombers On Runway Alert

Paris—American strategic bombers have been on runway alert armed with nuclear weapons on a round the clock basis since Oct. 1.

This was disclosed in Paris by Gen. Thomas S. Power, Chief, Strategic Air Command. Gen. Power met with reporters after briefing some 180 delegates from NATO nation parliaments now holding an annual session in Paris. Parliamentarians also were briefed by Adm. Jerauld Wright, Supreme Allied Commander, Atlantic, who is based at Norfolk, Va., and by Gen. Cortland Van Schuyler, SHAPE Chief of Staff.

Gen. Power told reporters his command bombers—those not on flying patrols—were capable of getting into the air 15 min. from the first alert signal. He added that SAC is working to keep about one third its reported 2,000 bombers on this 15 min. alert. Asked by one reporter if his bombers really were equipped with nuclear weapons, Gen. Power quipped: "Well, they're not carrying swords or bows and arrows."

Commenting on a recent statement by Soviet Communist boss Khrushchev, that American SAC bases all were vulnerable to Russian missiles, Gen. Power said: "This isn't so and no one knows it better than Khrushchev."

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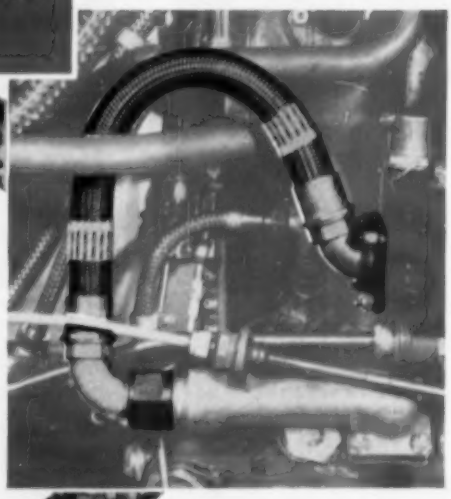

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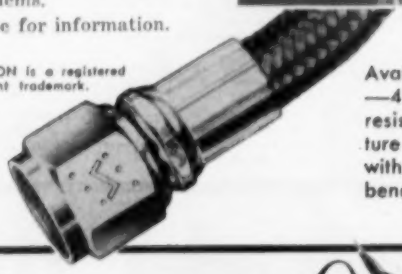

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plified Reheat (BSR) the thrust is increased to a static value of 8,170 lb. at sea level.

This engine will undoubtedly turn out to be the ultimate engine for the NATO light fighter program if that program reaches tangible orders. The reason is that none of the current contenders designed to the specifications can meet the takeoff requirements. More thrust is the only way out.

In one typical case, the Dassault Etendard 6 has been redesigned for the Orpheus 12 engine. The increased air flow meant an increase in fuselage cross-section area. The increased thrust meant that more fuel must be provided to meet the NATO mission profile. Luckily, Dassault found the extra fuel could be included within the increased dimensions of the fuselage made necessary by the installation of the Or. 12.

The reported changes in length and mass flow hint at possible configuration changes within the engine. For example, the compressor stages might be increased in number or another turbine stage might be added. Bristol won't say what the new engine is going to be like, nor will it say when it's expected. But other sources indicate the engine should be running by June 1958. Judging by Bristol's short development time for the Orpheus series, this schedule looks entirely possible.

Orpheus History

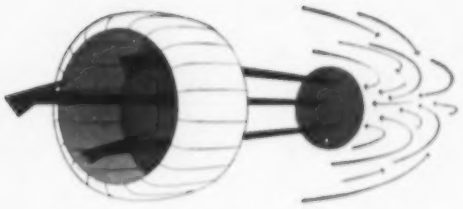
Background of the Orpheus line is rather checkered. It was not designed for the NATO light-fighter program, but rather developed to meet the requirements of the program.

The Orpheus originated as an expendable engine for a pair of expendable bomber projects being designed by Bristol and Vickers. The engine requirements, laid down in 1951, called for a turbojet of 3,000 lb. sea-level static thrust, weighing no more than 500 lb., and with no accessories. The thrust-weight ratio was six to one, which was a tough design goal in those days.

Bristol began work on an engine designated the BE. 17, but soon ran into the usual conflict between requirements and performance. The expendable features of the engine, which dictated low production cost, were not compatible with the required thrust-weight ratio and the performance. Ideally the engine would be an all-welded structure, for production ease; but unfortunately it would have to be welded to machining tolerances in order to produce the thrust.

Bristol decided on a more orthodox second approach to the unit but decided to retain as many features of the expendable engine design as possible. This proposal became the Bristol BE. 22 Saturn, rated at 3,750 lb. thrust, and was the original engine W.E.W. Petter chose

CAPABILITY



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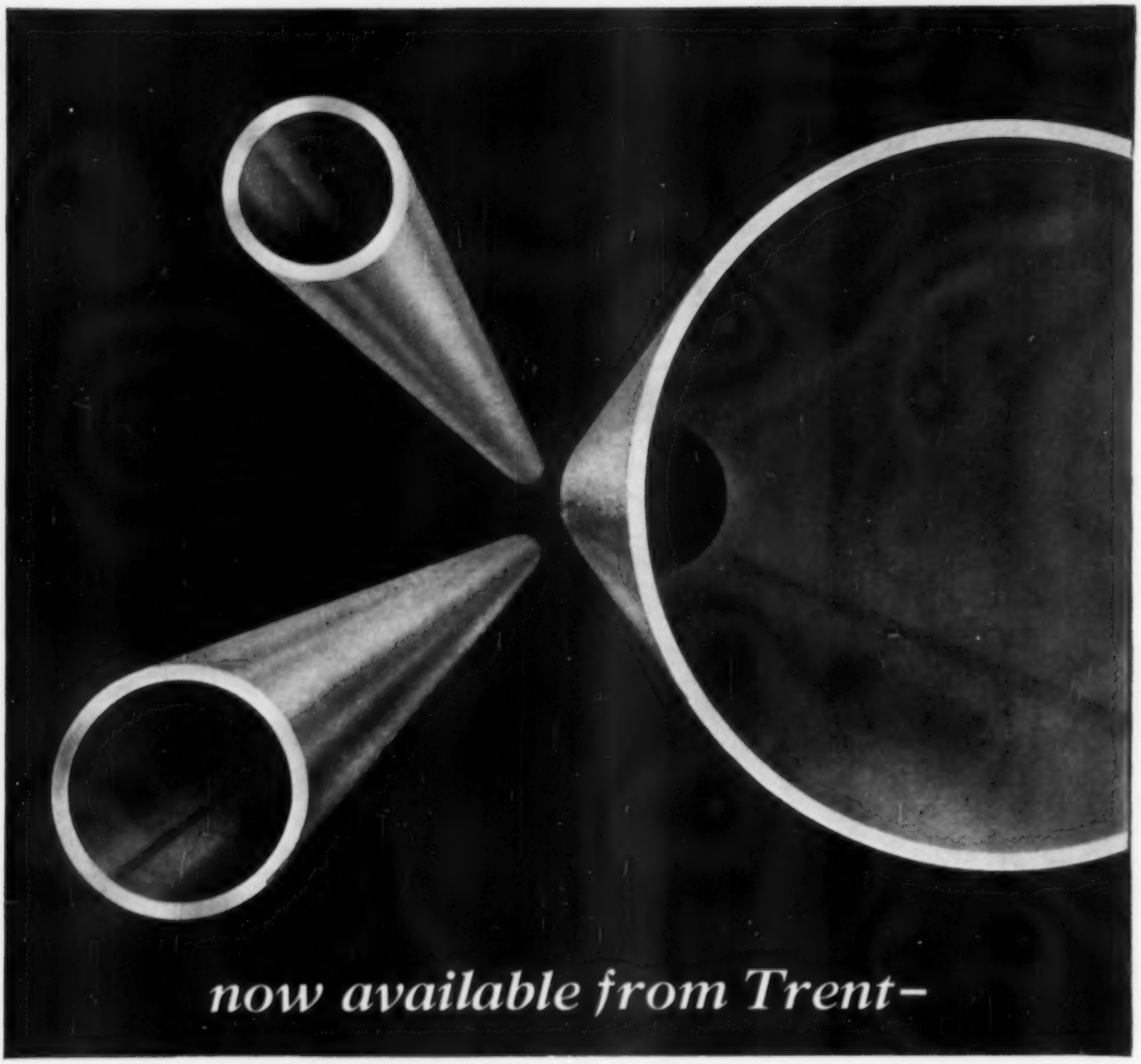

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as the powerplant for his Folland Gnat light fighter.

But the requirement for the expendable bombers was canceled and, right after that, so was the Saturn engine, for lack of funds.

Bristol engineers under Dr. Stanley G. Hooker remained convinced that such an engine was going to be needed and took another look at the whole problem of providing a lightweight, high-thrust engine. By then they had been exposed to the design thinking of Petter and had felt the growing surge of technical opinion behind the lightweight fighter concept.

So Bristol made the decision to develop a lightweight engine as a private venture, based on the feeling that somebody was going to need one fairly soon. This empathy with the existing situation paid off, because it probably was the future availability of the Orpheus engine more than any other factor that stimulated the final requirements for the NATO light fighters.

Formal design studies for the Orpheus series began in 1953, and stemmed from one of Hooker's suggestions. He proposed taking the low-pressure compressor from the Orion supercharged turboprop engine then under development at Bristol, and building a lightweight engine around it. This became the design proposal for the BE.26 Orpheus; as it happened, the Orpheus was an operating engine before the Orion.

Development Schedule

Detail design started at the beginning of 1954 when the first manufacturing drawings were issued to the shop in January. Rig testing of the compressor, turbine and other components began in the fall of that year. The first Orpheus prototype engine was started and run up on the test stand Dec. 17, 1954, less than one year after the start of detail design.

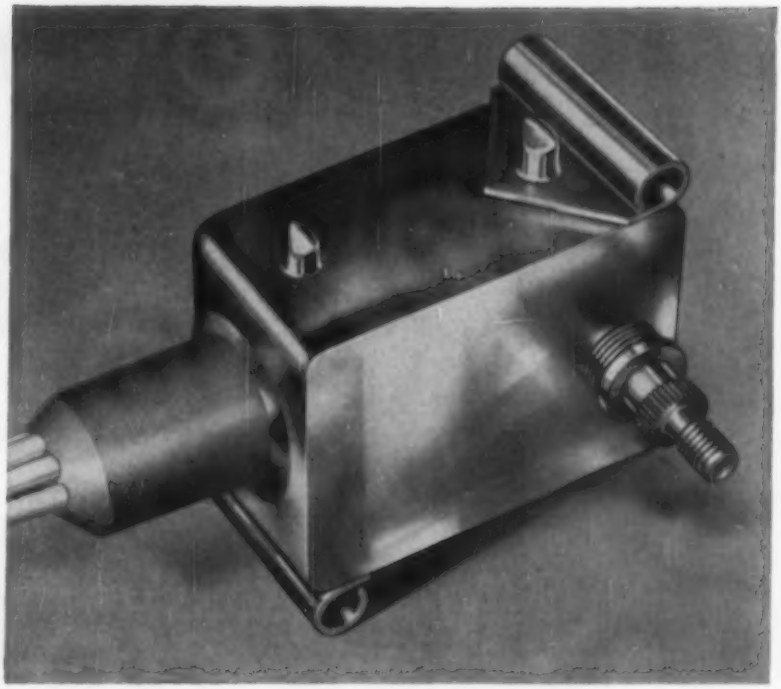
This engine, like prototype engines everywhere, was de-rated during its early development life. By May 1955 it had completed a 150-hr. type test at 3,285 lb. thrust and was cleared for flight.

The first flight was made in the prototype Folland Gnat July 18, 1955.

Type test followed type test. The Orpheus B. Or. 1 passed at 4,050 lb. static thrust in January 1956. In November that year the second development of the basic engine, the B. Or. 2, ran through its 150-hr. routine at 4,520 lb. and reached thrusts over 5,000 during the test.

The Orpheus 3, intended for the NATO fighters, was type-tested in May 1957 at 4,850 lb., the guaranteed thrust for the engines of the light fighter program.

Total flight and ground time on all



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marks of Orpheus is about 8,000 hr. now with about 500 of them flight time and the rest test-stand hours. Current airplanes flying with the Orpheus include the three NATO fighters—Breguet Taon, Dassault Etendard 6 and Fiat G.91—Folland Gnat, Lockheed Jetstar and Avro Ashton test bed.

Next Orpheus to take the air will be in a North American F-86 Sabre, modified as a flying test bed. The plane should fly before the end of this year.

Now the basic decision on which Orpheus and how many remains to come from the final evaluation of the NATO light fighter competition. It is almost a certainty that no Orpheus 3 engines, beyond the original 60 of the Mutual Weapons Development Program, will be ordered. The final engine for the light fighter projects will be the Orpheus 12. But the number depends on the number of fighters ordered, and that is still in the air.

Those airplanes other than the NATO fighters which use the Orpheus 3 will undoubtedly shift to the Or. 12 when it becomes available.

May Face Boom

Should the NATO order be placed, Bristol would be flooded with work on literally thousands of engines. There is the possibility that the Orpheus would be produced in numbers greater than any other turbojet except possibly the General Electric J47 and the Rolls-Royce Avon series.

There is also the possibility that the engine would die quietly with the death of the NATO program, because proposed alternate orders are few in number and would decrease if Mutual Weapons Development Program funds were cut off.

Bristol is in good shape to tackle the engine production that could come its way, although a tremendous order for NATO engines would probably, for political and technical reasons, be split among Bristol, Snecma and Fiat.

With everything to gain, Bristol's engineering gamble of 1953 is nearing the payoff stage.

Soviet Public Relations

Moscow—Russia is going all out to try and obtain full propaganda value from its rapidly-growing fleet of high-capacity helicopters.

Soviets recently flew a large helicopter to Brno, Czechoslovakia, to perform a construction job before the eyes of the gaping citizenry. In five flights, the craft lifted 3.5 metric tons of steel parts to the top of a new building. Thus, the Russians proclaimed, "in two hours a Soviet helicopter accomplished work which a lifting crane could not do in less than two weeks."

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CONVERTER—Liquid Oxygen Converter, 5 liter

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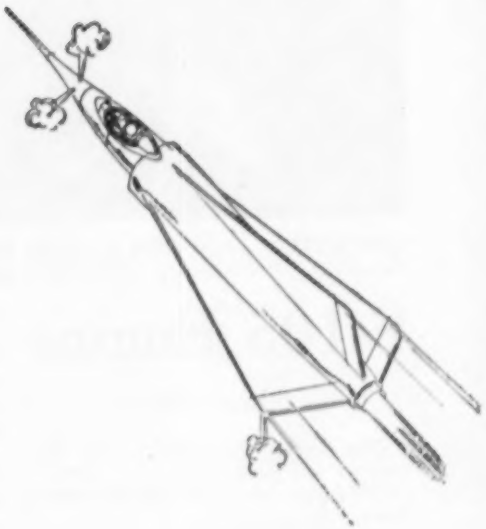
Honeywell's vast experience in flight control systems, instrumentation and engine controls makes it the logical company, not only to do this advanced work, but also to aid you in your airborne control problems. Contact Minneapolis-Honeywell, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13, Minnesota.

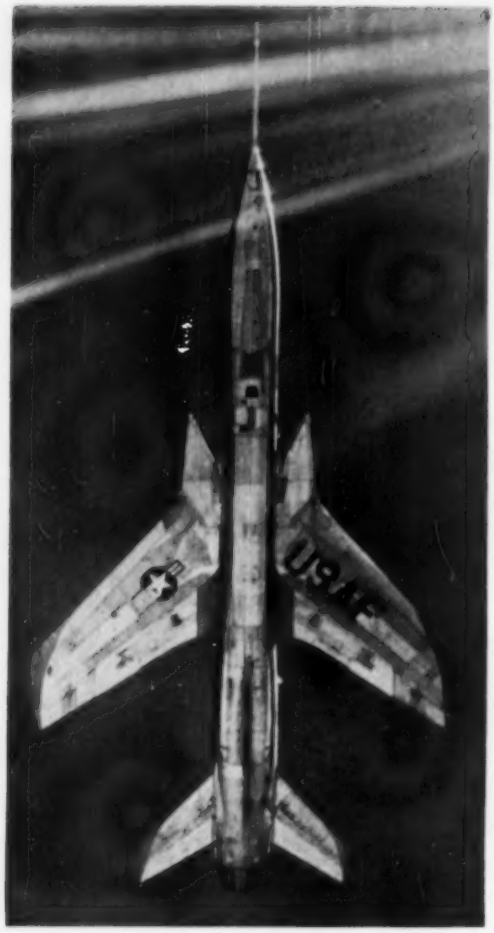


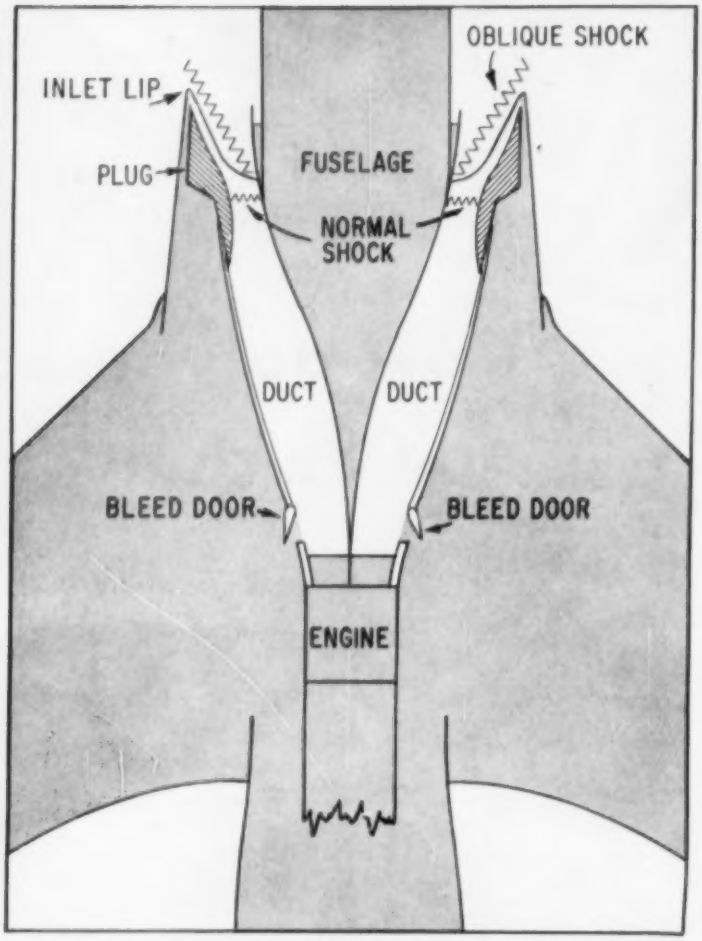
Will a plane such as this reach 250,000 ft.? In this artist's conception, reaction controls which port high energy gas from small rocket motors are located at wing tips and nose. Control is produced by generating angular accelerations in roll, pitch and yaw. Development of an automatic control system for this type of reaction control is now actively in progress at Honeywell Aero.

Honeywell

Military Products Group

Aeronautical Division • Ordnance Division • Boston Division





F-105 INLET for engine airflow is cut back to make it easier for excess air which builds up behind the shockwave as it moves back into the inlet to spill over the top and bottom of the inlet. Movable plug inside holds the normal shock, once it is inside, at best position.

F-105 Engine Inlets Efficient, Reliable

By Robert Cushman

New York—Inlets for Republic Aircraft's F-105 show recent trend toward internal-type inlets for aircraft above Mach 1.4.

The F-105 inlet is one of the first examples of a novel configuration devised by Dr. Antonio Ferri, now head of Brooklyn Polytechnic Institute's Department of Aeronautical Engineering and Applied Mechanics, when he was at National Advisory Committee for Aeronautics, Langley Aeronautical Laboratory. The Ferri inlet has the advantage of combining the efficiency of an internal compression shock system with the more reliable handling qualities of an external type. While it is probably not used much above Mach 2 in the F-105, it was the type of inlet chosen by Republic for its advanced F-103 before that aircraft was canceled. The F-103 is believed to have been planned for Mach 3 flight (AW Sept. 9, p. 101).

Comparing the F-105 inlets with the B-58 inlets (AW Jan. 14, p. 51), it can be seen that the F-105 inlets are not only side or cheek located, rather than front located, but they also are inside out in plan view.

The first shock starts from the outside instead of emanating from a ramp alongside the fuselage as it does in the Lockheed F-104 inlets.

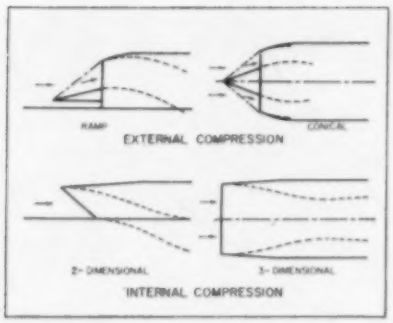
Faint Oblique Shock

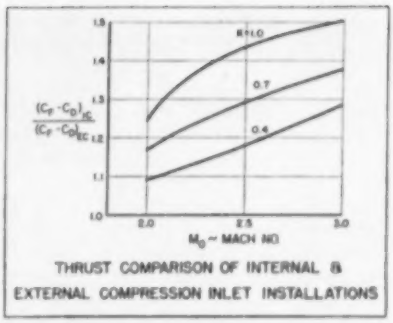
At first, because the F-105 inlets display the same oblique plus normal shock pattern, it might appear that it too is an external type. However, the difference is that in the Ferri inlet the oblique shock is faint and is merely the result of a configuration to get the normal shock inside the inlet. In the other two inlets, the designers have tried to make each shock about equal strength so each shares the job of reducing the supersonic airstream to subsonic values acceptable by the engine's subsonic compressor.

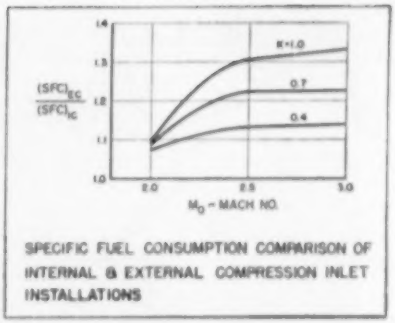
A Republic engineer told AVIATION WEEK that the oblique shock does only 5% of the compression work of the inlet system, while the normal shock does the rest.

A pure internal system would rely entirely upon a single normal shock inside the inlet. Harry Drell and Thomas Sedgwick of Lockheed Aircraft Corp. pointed out in a paper before the Institute of Aeronautical Sciences that even though an all-internal inlet system would be superior, especially at Mach numbers over 2, apparently no designer has discovered a practical means for starting such a system.

Ferri explained the problems of this type of supersonic inlets in his Patent 2,788,183, recently granted but filed in 1953.







CURVES by Lockheed engineers show on a theoretical basis that internal inlets, because of lower cowl drag, are 20-30% better than external inlets in the Mach 2-3 region. Thrust to drag ratios for two types are plotted against Mach numbers. Additional variable K, represents ratio of cowl drag for axial symmetric inlet to that of two-dimensional inlet; shows nose, pod types are superior to cheek types.

For maximum pressure recovery, the patent read, an inlet is provided with a restriction downstream of its leading edge. When functioning properly at supersonic flight speeds, the inlet flow upstream of the inlet throat is supersonic, while downstream of the inlet throat the flow is subsonic. In this condition the inlet is said to be started.

However, the problem is to get the inlet started. For the inlet to start after sonic flight speed is exceeded, the Ferri patent says, a strong shock wave which divides the supersonic flow from the subsonic must move from the inlet entrance (where it will of course form as the aircraft comes up past Mach 1) down the inlet to the throat restriction. The mass of air that will pass through the inlet will be greater in the started condition so that during starting, part of the air downstream of the strong shock wave must spill outside the inlet as it moves back.

Inlet Flow

Ferri pointed out that because a wide, thin inlet would have the greatest spill area, it would be the easiest to start. In the case of the F-105 it can be seen that flow can spill over the top and bottom of the wide narrow inlet while the first shock is moving back.

After the first shock has moved back, the faint oblique shock caused by the outboard edge of the forward jutting inlet will form.

In the particular Ferri patent referred to, Ferri said the trouble with wide narrow inlets such as are integrated into the leading edges of the wing roots on the F-105, is that the resulting drag is high. In his patent he therefore proposes that a series of these outward jutting inlets be so grouped side by side that they retain their starting advantages but present lower drag configuration for the aircraft. The inlet area in effect would be divided into a series of smaller jutting shapes which are staggered to spill their overflow into each other, cascade fashion.

Once the F-105 inlet system is started, a further refinement of a moving restriction inside the outboard inlet entrance is used to stabilize the flow. This restriction compensates for variations in aircraft speed upstream and engine operation downstream. Floating bleed doors further downstream just ahead of the engine add to the system's ability to handle flow transients.

Reliable Controls

Lear Inc.'s Grand Rapids, Mich. Division which makes the control and actuation devices for the F-105 throat restriction plug says it has perfected an especially reliable system.

Unlike the B-58 inlet control system, the Lear F-105 system controls the variable inlet geometry by a partially open loop system wherein the plug position is scheduled from the aircraft's flight Mach number. The B-58 used a tighter closed-loop control working directly off signals from pressure-sensing probes extending from the inlet lips into the external shock waves. Lear says it has avoided pressure probes because of the difficulty of obtaining signals at higher Mach numbers.

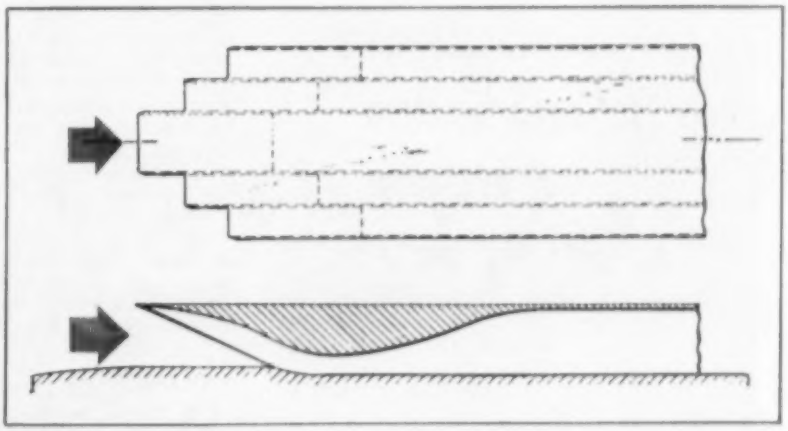
Lear engineer William Stubbs told Aviation Week it is important that the inlet controls be reliable. Critical conditions which could arise if they are not:

- **Overtemperature** of the engine turbine from shock buzzing if the plug is moved to a wrong position.
- **Large sudden** drag load on aircraft with attendant loss of engine thrust output if flying supersonic and plug goes to subsonic.
- **Difficulty** of landing aircraft if plug sticks in supersonic position.
- **Complete loss** of performance potential of aircraft if plug sticks in subsonic position.

Fail Safe

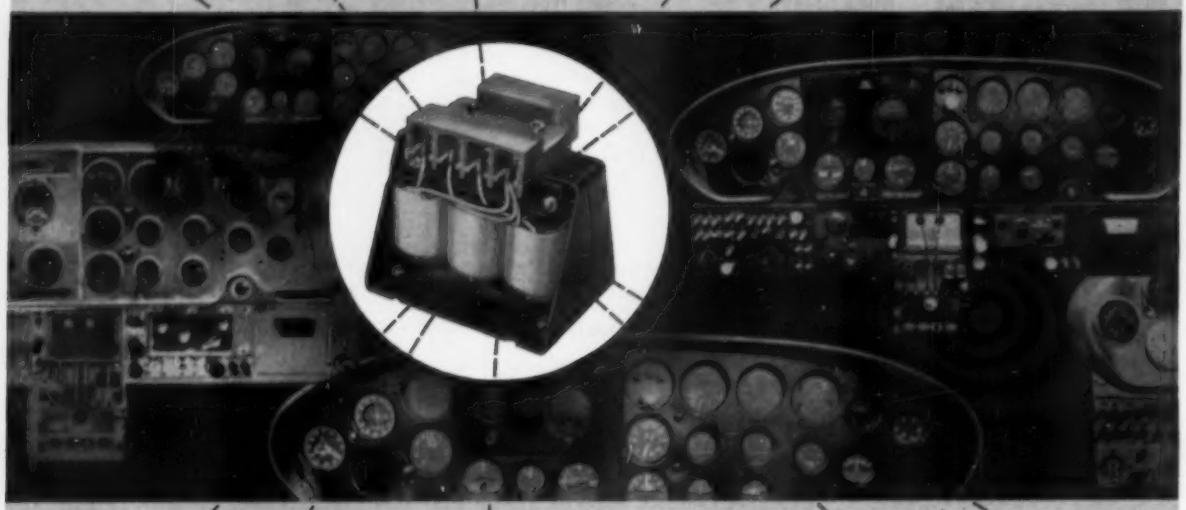
Stubbs said that the aerodynamicists indicated it would be a serious failure when the controls men asked them what would result from equipment malfunctions. The Lear system, said Stubbs, is designed to always fail safely in one selected position.

Lear also developed and is producing inlet controls for the Convair F-106. The F-106 inlet appears more conventional and uses an adjustable internal restriction on the fuselage side of the inlet duct.



STAGGERED scoop inlets invented by Ferri combine low drag compactness with easy starting capability. Middle scoop spills flow out to set-back scoops on either side.

behind these panels



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IAS Stresses Defense Management Skill

By Craig Lewis

Dallas—Management ability as distinct from—and essential as—engineering skills in the functioning of the weapon system concept was a major area of discussion here at the first Midwestern National Meeting of the Institute of Aeronautical Sciences.

Meeting in an atmosphere of national excitement over recently demonstrated Russian technological advances, delegates were told by Lt. Gen. S. E. Anderson, commander of Air Research and Development Command, that a high order of management skill will be vital in the U.S. effort to meet the Soviet challenge.

Need for Knowledge

The ARDC commander also observed that the aircraft industry cannot afford the luxury of ignoring knowledge and information developed by others. "You in industry must make use of every facility at your command to further the exchange of technical information," he said.

Further recognition of the demand for a high type of management skill came from Gen. Orval R. Cook, USAF (ret.) president of the Aircraft Industries Assn. He pointed out that on the policy level, management competence has a greater importance than engineering or scientific talent. "Whether we like it or not, technical competence and management competence are not synonymous," Cook said.

Observing that the real weapon system manager has to be in the military unless sometime in the future the conduct of war is to be by contract, Cook cited the need for close relationship between military managers and the industrial managers to whom they delegate a portion of their responsibility.

Tracing the history of weapon system management, William F. Ballhaus, vice president and general manager of Nortronics Division, Northrop Aircraft, Inc., observed that the concept has developed on two levels "that lie back to back."

On one level, the Air Force has developed a system in which weapon system project offices bring systems through the ARDC and Air Materiel Command phases under joint ARDC-AMC management. While this approach is a step in the right direction, Ballhaus said, the USAF management operation is hampered by the policy of rotating officers in three-year cycles.

In view of the time it takes to develop a weapon system, plus its service life of anywhere from three to seven years, Ballhaus observed that it is possible to have as many as five complete management changes in the Air Force on any long range program.

Ballhaus pointed out that USAF has adopted two approaches to combat problems of increasing weapon complexity and "the ever changing management posture of the Air Force." First approach involves use of a contractor for long range management of overall weapon systems under guidance of weapon system project office. Second solution is applied to more complex systems and involves establishment of a special organization such as Western Development Division to handle some of the more complex weapon systems.

Other level of weapon system management development has been in industry where managers have not only had to cope with more complex system, but have also had to expand into the operational, maintenance and economic phases of these systems.

Ballhaus said that in spite of increasing system complexity, continuous effort must go toward simplifying the management job. If the management job is simplified, "complex systems will be much clearer to the people who are associated with elements of the weapon system program.

Most Important Factor

"They will be able to see in addition to all their technical problems, the underlying factor which has become most important in all weapon systems today," Ballhaus said. "That factor is cost."

Management of the Army guided missile program was discussed by Dr. Martin Schilling, chief, projects management staff, Research and Development Division, Redstone Arsenal. Reviewing the Army management approach, Schilling said that of every development dollar received by Redstone Arsenal, 80 cents goes into the efforts of industrial contractors.

Requirements of integrated programs aimed at delivery of needed weapons on time dictate central agencies to control these programs, Schilling said. He added that "system management is required for guided weapons within a government control agency and as well with those groups where the development and subsequent production are actually performed."

Scheduling Inventions

Discussing scheduling problems, Schilling observed that some authorities maintain that "you cannot schedule invention.

"The simple truth," Schilling said, "is that you must schedule and therefore must limit inventions to an acceptable measure in order to reduce the scientific achievements of the developer to the practicalities of a weapon system in time for it to do any good."

Turning to guided missile budgeting problems, Schilling observed that occasionally the idea of "crashing" a missile program with collateral overfunding is either proposed or actually carried out.

With a single missile system, Schilling said, good management, streamlined administrative procedures, and timely and steady funding can produce outstanding results, and overfunding

FJ-4B Markings

North American FJ-4B operating with Fleet Air Gunnery Unit, Miramar NAS, Calif., bears new fleet markings on tail, wingtips, nose. Aircraft is an FJ-4 Fury fighter modified for low altitude attack operations. The FJ-4B is powered by a Curtiss-Wright J65 turbine engine developing 7,800 lb. thrust (AW Jan. 7, p. 28). Note cambered airfoil.

ENGINEERING REPORT

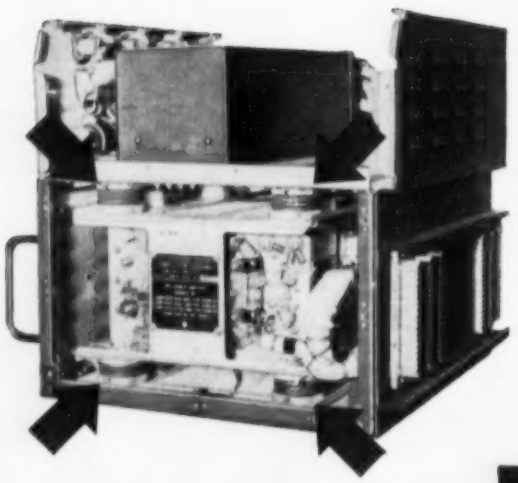
A Case History of Environmental Control

PROBLEM

VIBRATION • SHOCK AND COOLING

POWER TUBE FAILURE during environmental testing of the Servo-Amplifier in the flight stabilization system of Chance Vought's F8U-1 Crusader.

SOLUTION



ENGINEERED MOUNTING SYSTEM:

Robinson Model 1514 all-metal light-weight mounting system to protect entire Servo-Amplifier assembly. Highly damped Met-L-Flex resilient elements are incorporated in an opposed cushioning design. Resulting center-of-gravity suspension system assures all attitude protection for power tube and other electronic components.

The Servo-Amplifier assembly was isolated with no increase in over-all equipment dimensions.

SPECIAL FEATURE:

Range of environmental protection is extended by screened cooling apertures designed as part of the combined chassis and mounting.

PERFORMANCE:

Natural frequency of the mounting system is between 15-21 c.p.s. After 15 G drop tests on all six sides, there was no loss of isolation efficiency which remained as high as 90% at 55 c.p.s. with .060 inches excursion.

RESULT:

1. Increased operational reliability of Chance Vought's supersonic Crusader.
2. Another contribution to the weapons system reliability program pioneered by Chance Vought Aircraft, Inc. in cooperation with Robinson engineers.

ROBINSON CONTROL IS RELIABILITY CONTROL

ROBINSON

AVIATION, INC.

Teterboro, New Jersey

West Coast Engineering Office, Santa Monica, California

alone buys little or nothing as a rule if technical requirements remain the same.

Crash programs compromise technical requirements, and this defect must be compensated for. One promising way, according to Schilling, is to invite technical competition or undertake parallel developments in component fields or even with whole systems.

In this case, over-funding serves the purpose of creating a sufficiently broad selection of potential solutions from which to choose, Schilling said.

Role of operations research was discussed by H. F. Marx, chief, engineering research, Temco Aircraft Corp. He pointed out that operations research provides a continuous evaluation of the effectiveness of a weapon system in its tactical environment all through the system's development period.

Throughout this running analysis of system effectiveness, Marx said, the main emphasis is the isolation of the weaker links in the weapon system chain and investigation of possible ways of improving them during the design development period. In addition to this technical function, operations research has become a valuable tool for management to use in making plans and policy. For example, Marx cited the use Temco has made of operations research to assess future military procurement markets and the changing balance between aircraft and missiles (AW Sept. 9, p. 75).

Marx said that in order to be effective, operations research teams need access to all relevant information—sufficient time, as free as possible from crash situations, to do objective research—and freedom to make recommendations as they see them regardless of current or preconceived policy.

Role in Reliability

In the field of missileborne electronics, success or failure in quickly achieving high reliability is primarily due to management, according to F. W. Lehan, associate director, electronics research and development staff, Ramo-Wooldridge Corp. Lehan said that his experience with the reliability design of a number of missile electronics systems indicates that success is more a function of management structure and characteristics than the average caliber of engineering talent.

Management's responsibility is to recognize the problem, define the problem to its people and see that they are adequately educated in the past experience of others with the problem, Lehan said.

Management should also see that a detailed and scheduled approach is made to the problem with many feedback loops going to those whom the program manager has seen are responsible and

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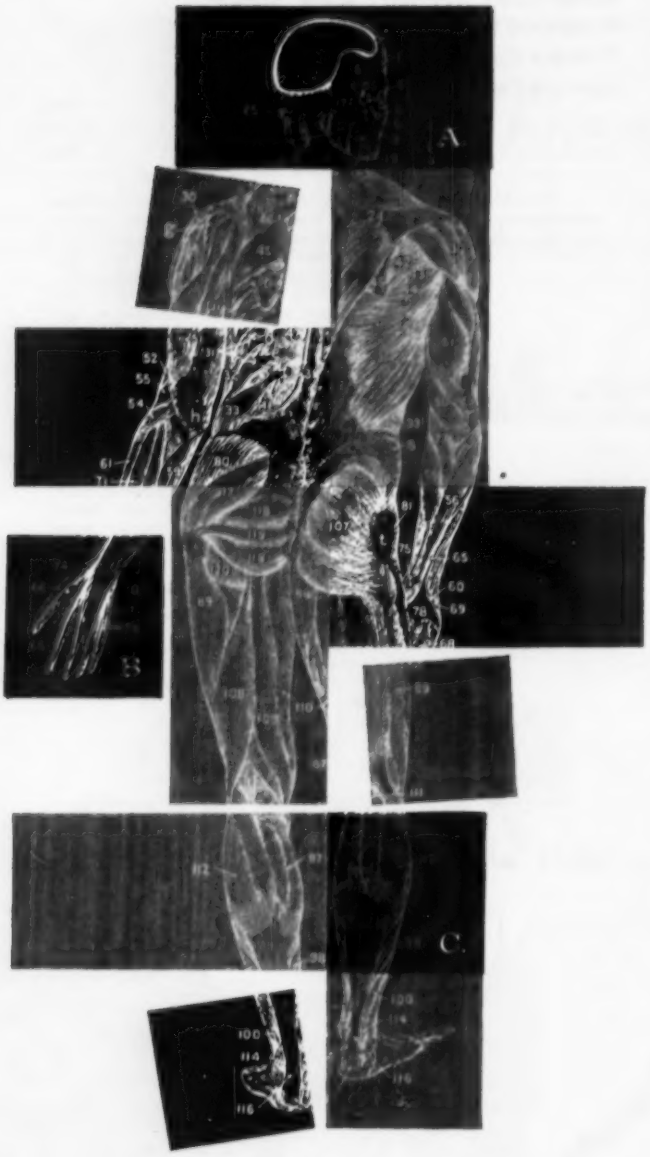

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able to take effective action in correcting difficulties, he said. Management should also provide staff assistance.

"The engineer who understands why a given specification is necessary, who, along with his superior, sees his early equipment fail under environmental test immediately after it has left his hands, will be fast to correct the failure," Lehan said. "But the engineer who does not understand the reason for the specification, who is provided no opportunity for the observance of troubles, and who hears, perhaps months later, that someone has alleged that his equipment was the cause of a missile flight failure, is quick only in defending his position in the initial design of the equipment."

Need for Research

When the program manager has things under control and has shown the military his organization can build reliable equipment quickly, he spends some time on advance thinking, Lehan pointed out. Thus the manager can recognize the need for research in making the equipment lighter and cheaper, and he can see there is some sophisticated work to be done in shock mounts and packaging concepts. And he has the background to sell this program to the government "because he also sees that his effective management action is an essential part of any practical reliability program," Lehan said.

Purchasing program for the high performance B-58 weapon system was described by Robert Kahn, manager, Material Department, Convair Ft. Worth Division. He pointed out that the performance specifications of the B-58 created new problems for the vendors involved in developing subsystems for the new bomber. Since the supersonic B-58 weapon system involved some new concepts and new requirements in subsystems, Kahn observed that it was important for Convair to choose competent, reliable vendors for these subsystems. Vendors were chosen through an elaborate program that involved visits by vendors to Convair Ft. Worth and visits by Convair evaluation teams to vendor plants.

Kahn said that one of the problems Convair faced was convincing vendors that the company did not intend to usurp vendor fields in producing the B-58 under the single manager concept. He pointed out that 47.2 cents out of every dollar in the B-58 program goes to subsystem vendors.

Integrated design can produce more efficient cooling systems for crews and electronic equipment in high performance aircraft, according to P. E. Petty, propulsion engineer, Chance Vought aircraft.

Petty told IAS delegates that crew and electronic cooling systems of high

performance aircraft can be integrated into a single efficient system if cooling characteristics of the crew and electronics equipment are designed to be compatible and are matched to the aircraft performance envelope, and if the system is installed so that it can take advantage of every available Btu. before dumping the cooling medium overboard.

Cooling Answer

By developing an integrated cooling installation for both the crew and electronics gear, the cooling system designer can often show the weapon system manager the advantages and disadvantages of spending time and effort in designing or redesigning electrical components to improve their cooling characteristics, Petty said.

This approach not only can solve the aircraft cooling problem, but it can greatly reduce the magnitude of the electrical equipment designer's cooling problem, resulting in a better, more reliable component, faster, he said.

Petty warned that if the cooling system designer does not establish his flow system early in the initial design and direct installation of equipment accordingly, "the cooling system can become a veritable monster saddling the aircraft with needless weight for ducting and controls, and operating at low efficiency."

Laboratory simulation is a valuable tool in analyzing and improving subsystems, according to J. E. Goode, chief of aerophysics, Convair Ft. Worth. Goode delivered a paper on subsystem design evaluation.

Subsystem requirements should be developed from overall weapon system requirements, making possible more intelligent and efficient work in all phases of subsystem evaluation, Goode said.

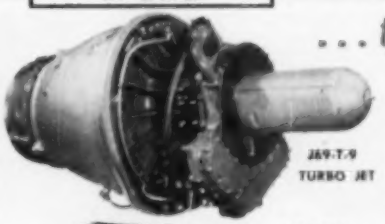
This background knowledge "is particularly valuable when the need for a compromise arises or in cases where the requirement is somewhat intangible and thus requires interpretation," he said.

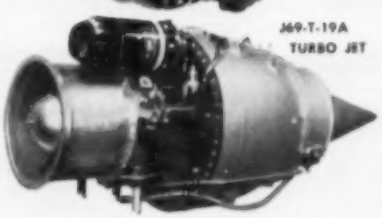
Early Stages

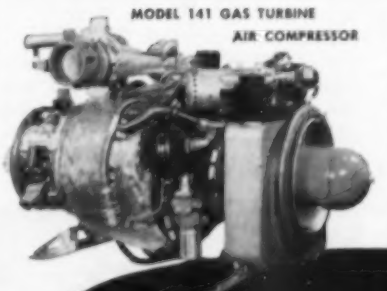
Analytical evaluation of subsystem functional design in the early design stages permits usage of more complete airframe data and other subsystem data, and can point up improvements when they can be made most economically and efficiently, Goode said.

The Convair aerophysics chief pointed out that this evaluation is not repetition of preliminary subsystem analysis but is an approach that takes full advantage of latest knowledge of the airframe and other subsystems.

Final phase of evaluation is experimental testing in the laboratory and in flight. Goode said that for functional evaluation, the most fruitful laboratory







... the T-37 Twin Jet Trainer with C. A. E. Turbine Power

Air Corps flight training routine took a significant step forward recently, when the T-37 twin jet trainer entered its Phase VIII testing at Bainbridge Air Base, Georgia. Twenty hand-picked officers embarked on a course known as PROJECT PALM, with the two-way goal of training for them, and suitability testing for the plane. This new high-performance ship advances the jet phase of fliers' training to an earlier stage in the training schedule, speeding the transition from propeller-driven planes to jets, with gains in both safety and economy. Twin J69-T-9 turbines by C.A.E. provide the power.

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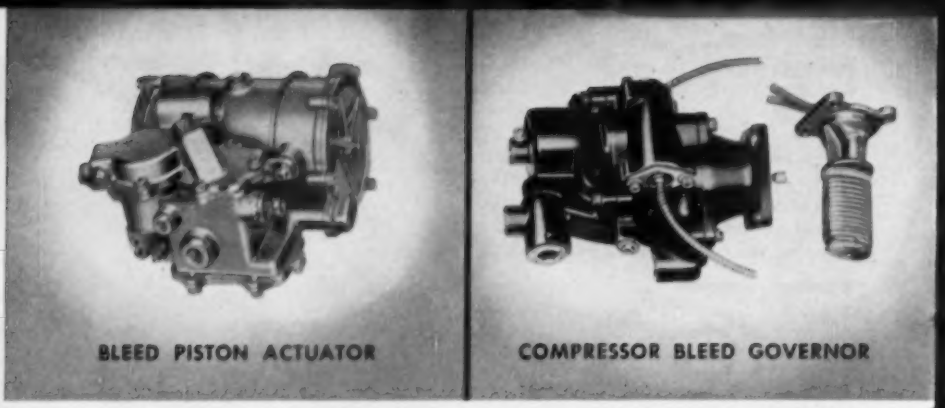
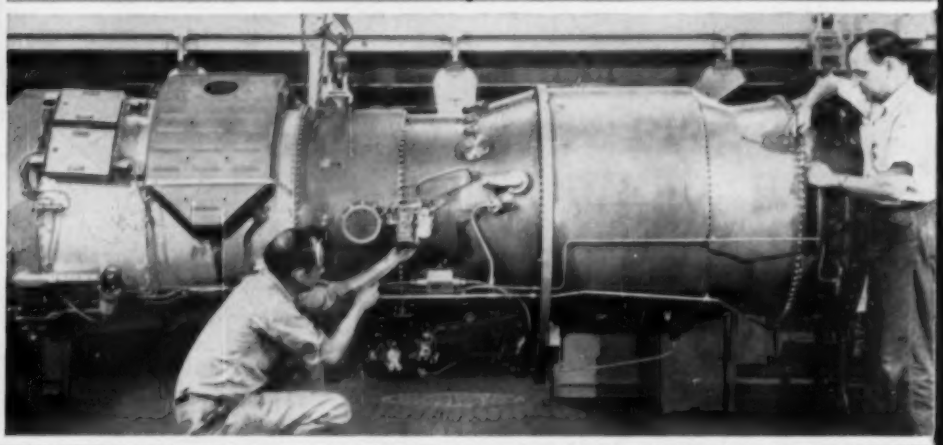
Holley engine controls selected for JT4 engines on America's first jet airliner



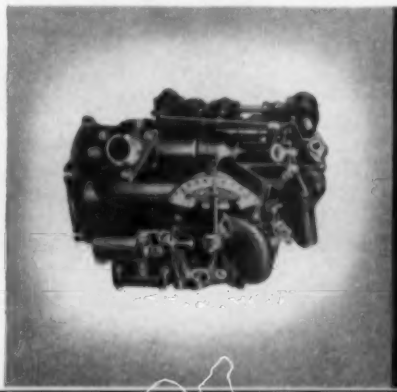
BLEED PISTON ACTUATOR

COMPRESSOR BLEED GOVERNOR



Powered by four JT4 Pratt & Whitney Aircraft engines, the Boeing 707-320 will carry 131 first class passengers from New York non-stop to the Continent in just over six hours! Each of these new engines, commercial counterparts to the J-75 which drives many of America's latest jet fighters, delivers up to 15,000 pounds of thrust. Ability to pack so much added power into a relatively small space is the result of designing engine components which will operate at higher efficiency, require less area and reduce over-all weight.

Holley Carburetor Company, working closely with Pratt & Whitney Aircraft engineers, carried out this exacting assignment on such vital engine components as: the compressor bleed governor, and the bleed governor actuator. For single and multi-engine military aircraft, the Holley main fuel control is a companion unit to the Holley governor and actuator.



For military applications, the Holley main fuel control (right) is a companion unit to the governor and actuator.

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tests are those using simulation, usually of the airframe, but sometimes of other subsystems in this phase, nonlinearities and other physical anomalies are brought to light and appear in a quantitative form.

Goode observed that the value of light tests can be greatly enhanced if they are both preceded and followed by laboratory simulation work. Flight testing of a modern weapon system is a large undertaking covering many subsystems and pieces of equipment other than the subsystem being evaluated, he pointed out, and test conditions are sometimes difficult to control.

Many of these problems can be minimized or eliminated in laboratory simulation, Goode said, with the result that a simulation setup is effective in reproducing troubles encountered in flight.

Thin Wings of CF-105 Influence Hydraulics

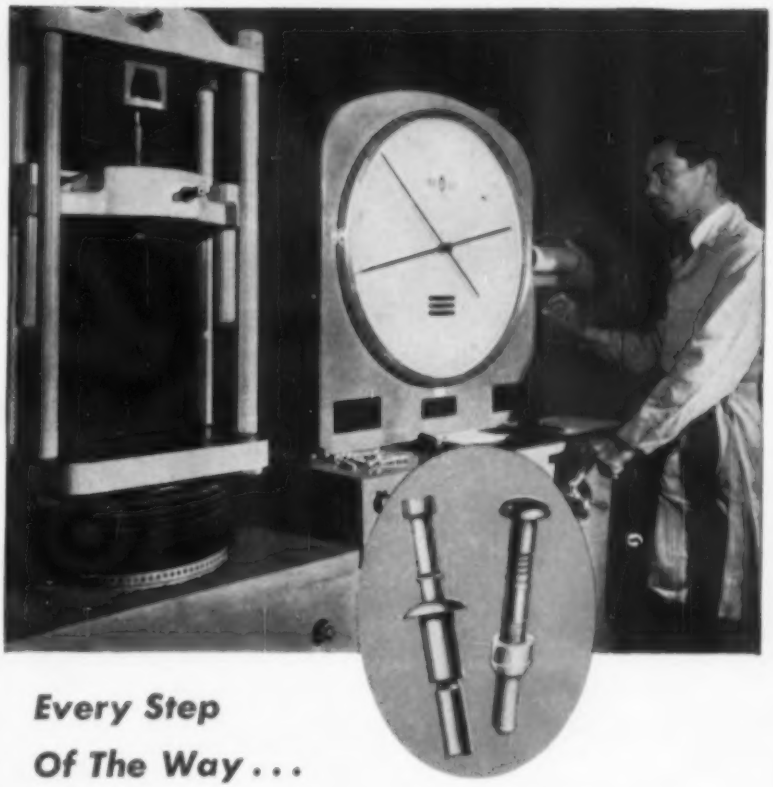
Detroit—Designers of the Avro CF-105 Arrow were forced to use a 4,000 psi. instead of the usual 2,000-3,000 psi. hydraulic system because of limited space for elevator actuators in the supersonic interceptor's wings, B. S. Wood of Avro told the annual Vickers Hydraulic Conference here.

Each actuator had to meet a dynamic output exceeding 50,000 lb. at 40 deg./sec. elevator movement and was required to fit chordwise into the restricted space bounded by the trailing section of the thin wing section.

An increase to 5,000 psi. was considered but was felt too far beyond the present state of hydraulic equipment art. As it was, Avro had difficulties in finding equipment for the high pressure system. Wood said most of the equipment is now ready and is being ground checked before flight test of the CF-105. The 20 gpm. pumps used in pairs to supply the aircraft's three hydraulic systems are currently being qualified at Vickers. Though leakage and wear problems have been encountered, Wood said that the pump (Vickers PV-4915) appears airworthy.

Once the higher pressure was accepted, Avro found that it was easier to fit the rest of the hydraulic equipment throughout the plane. For example, transmission line could be one standard size smaller in diameter than a 3,000 psi. system and it was easier to squeeze the pumps on the engine gearboxes. Because of the higher power available, it was easier to retract the landing gears within the four seconds allowed by the supersonic fighter's rapid acceleration.

Three independent hydraulic systems are used on the CF-105: two for the tandem actuator flight controls and one



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The methods—many of the machines—the quality tests were devised by Cherry Research to give the aircraft industry and the military efficient fastening. In addition, they are supplied in the volume needed to keep production lines moving on schedule. The Santa Ana plant has the highest rivet capacity in the world.

These are reasons why Cherry Rivets and Lockbolts are standard in the aircraft industry—and why they give maximum performance —make possible lower unit costs.

For information on how Cherry fasteners and the tools for installing them can help improve your fastening efficiency, write to Townsend Company, Cherry Rivet Division, P. O. Box 2157-N, Santa Ana, California.

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for the utility circuits. Altogether they total 300 hp. as against the Avro CF-100's 15 hp., which vividly illustrates the size jump between the two planes.

Because of the CF-105's size and speed, the flight controls are all-hydraulic with no direct pilot control, and the added complications of artificial feel as well as stability augmentation due to speed had to be built in.

The system uses Mil-0-5606 hydraulic fluid operating between —65F and 275F temperature limits.

Contrasting Avro's decision to go to a 4,000 psi. system, Conrad Cooke, of the Martin Co., cited calculations which showed that although a 4,000 psi. system would offer advantages, especially that of space saving, he did not think that the amount of the gain justified raising the standard to 4,000 psi.

Temco Sales Up 47%; Research Trims Earnings

Temco Aircraft Corp. sales for the first nine months of 1957 totaled $89,739,000, an increase of nearly 47% over the same period last year. Net earnings were down to $1,740,000 compared to $2,127,000 in the first nine months of 1956. Firm attributes this to more than doubled expenditures for research and development. In the first three quarters of this year these totaled $3,725,000 compared to $1,610,000 for such work in the 1956 comparable period.

Economy measures the past few months, including some layoffs, were factors in boosting sales and gross earnings figures. Layoffs are attributed to stretchouts in McDonnell F3H Demon Navy fighter component production contracts and other programs.

P.1 Development Fighter Readied for First Flight

First of the development batch of English Electric P.1 fighters is expected to make its first flight soon. Prototypes of the P. 1A and P. 1B have been undergoing flight test for some time but under a scheme similar to USAF's Cook-Craigie Plan, the government has ordered 20 of the supersonic fighters for development testing.

Rocket Engine Aircraft Reaches Record Height

London—Altitude record of 70,310 ft. set on Aug. 28 by an English Electric Canberra B.2 has been confirmed by the International Aeronautical Federation.

It is the first official world record set by an aircraft fitted with a rocket motor. The Canberra was powered by a Napier double Scorpion rocket engine and two Rolls-Royce Avon turbojets.

Armco 17-7 PH Stainless Steel

Specified for Many Parts in Lockheed's New Electra

Unique properties of special Armco Stainless contribute to exceptional performance and economy of America's first propjet airliner

In the new Electra, Lockheed brings propjet speeds to commercial aircraft. And combining its 7 mile-a-minute performance with the traditional stamina, safety and dependability of America's airliners demanded the best of aircraft materials.

That's why Lockheed engineers have specified Armco 17-7 PH Stainless Steel for many critical parts of the Electra. Where operating conditions are severe, the unusual combination of properties offered by this special Armco Stainless meets requirements most effectively.

The high strength-weight ratios of 17-7 PH at room and elevated temperatures assure resistance to stress and heat, and its excellent fabricating characteristics simplify production.

Design and Production Advantages

Readily available in sheet, strip, plate, bar and wire, 17-7 PH, when heat treated to Condition TH 1050, has a typical room temperature tensile ultimate strength of 200,000 psi, 0.2% tensile yield strength of 180,000 psi and unusually high mechanical properties up to 900 F. On a strength-weight basis it is one of the strongest aircraft materials available.

Equally important in both design and production, 17-7 PH is easy to fabricate by standard methods. It is readily formed, drawn or welded in the annealed easy-to-work condition, then its mechanical properties are fully developed by a simple heat treatment.

Armco 17-7 PH Stainless is used extensively in America's newest commercial airplanes, military aircraft and missiles. Both 17-7 PH and Armco's new ultra-high strength stainless PH 15-7 Mo, offer you many possibilities to solve your design and production problems economically.

For complete information on the properties and fabrication of Armco 17-7 PH and PH 15-7 Mo Stainless Steel, write to us at the address below.

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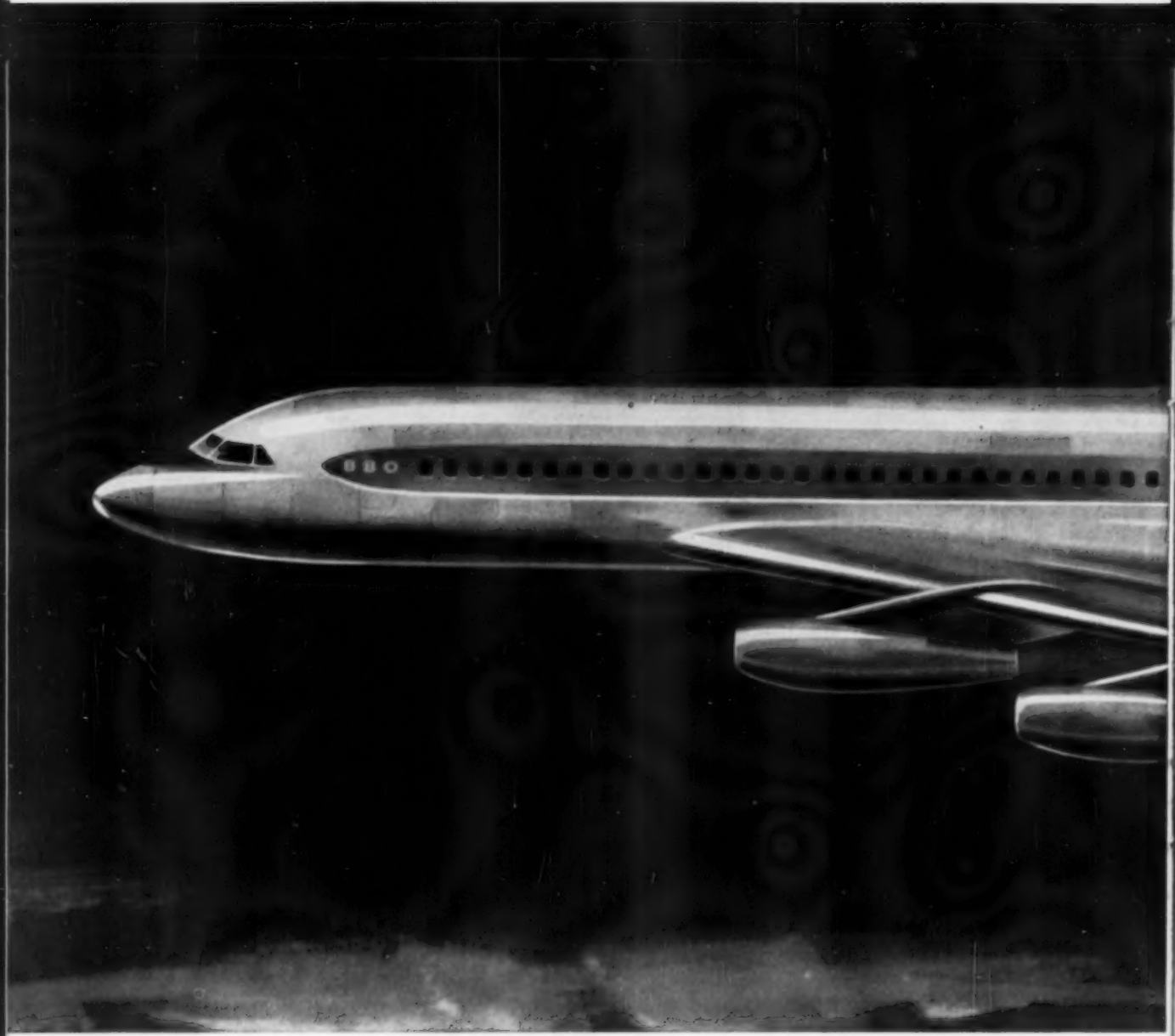

To protect jetliners from hydraulic fluid fires . . .

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For improved protection against hydraulic fluid fires, all 30 jetliners in Trans World Airlines' new Convair 880 fleet will come factory-equipped with Skydrol 500, fire-resistant hydraulic fluid.

Skydrol is the practical solution to concern about danger from hydraulic fluid leaks. It is a fire-resistant, lubricating chemical, not an oil. Today, more than 700 airplanes in 40 of the world's major airlines are protected by Skydrol. They have logged over 8,000,000 flying hours . . . overwhelming proof that Skydrol gives practical operation. Tomorrow, when a TWA Convair 880 speeds from New York to Los Angeles just a step behind the sun, it will enjoy proved service from Skydrol 500.

Jet- or propeller-powered, there's a Skydrol for your aircraft. Conversion from your present fluid is easy and costs comparatively little at overhaul time. Or, if you're ordering new aircraft, simply specify a Skydrol firesafe hydraulic system as original equipment. Protect your planes and passengers from threat of a hydraulic fluid fire. Be safe . . . with Skydrol.

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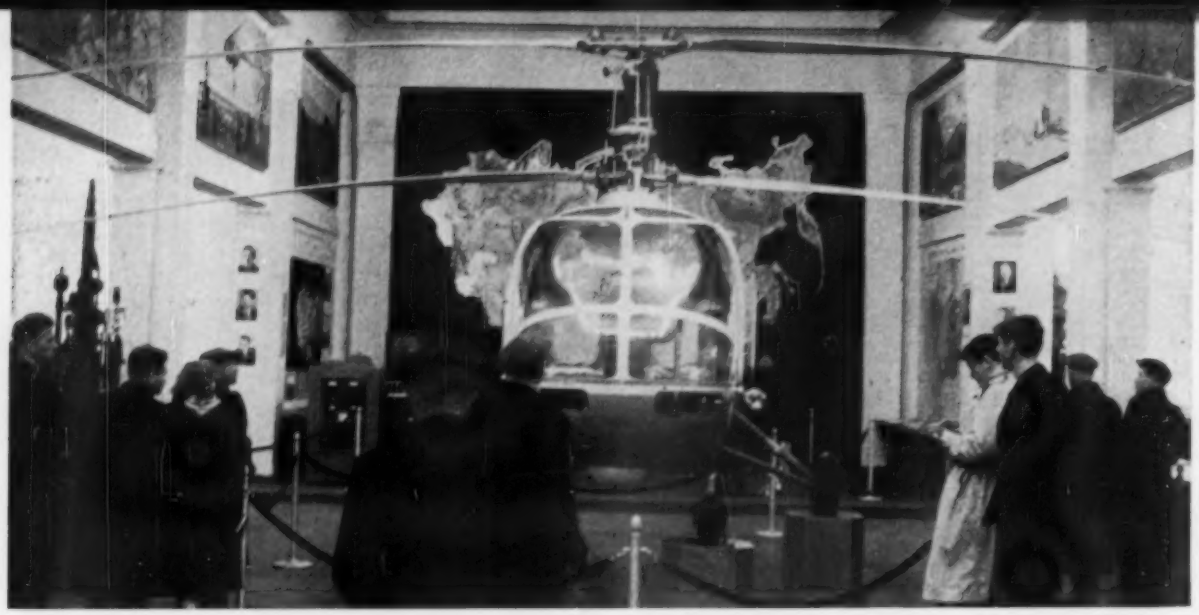


Russians Exhibit Coaxial Rotor Ka-15 Helicopter

Russian Ka-15 twin-rotor helicopter pictured here is currently being displayed in Moscow. N. I. Kamov is designer of the aircraft. The contrarotating rotors are powered by one 255 hp. engine. Maximum speed is reported to be 93 mph., and cruise speed is 78 mph. The two-passenger craft has a range of 2½-4 hr. and a ceiling of 10,000 ft. Kamov created two designs utilizing the dual coaxial rotor concept: the Ka-15, which is now in production as a rescue and agricultural pest control vehicle, and the larger Ka-18 which can carry four persons. Kamov has indicated that his next helicopter design will be powered by gas turbines (AW Aug. 12, p. 33).

CL-41 JET TRAINER MOCKUP shows mounting of horizontal tail above vertical fin. Twin inlets, on either side of fuselage, will feed single turbojet, which will exhaust at tail. Mockup faces scale presentation of runway (right) to provide evaluation of cockpit vision.

Canadair Stresses Versatility in Trainer

Canadair, Ltd., Montreal is spurring development of its new side-by-side seating CL-41 jet trainer by building two prototypes, scheduled for completion in fall of 1958.

Existence of the project, in the wind tunnel and mockup stages until recently, was first revealed in AVIATION WEEK (Jan. 28, p. 71).

Initially designed to fill primary through basic flight training missions, Canadair CL-41 jet is also planned for additional roles. Company reports these future developments of the basic airplane:

- **Ground support role** in addition to weapons training, will be possible through use of an armament pack, now in preliminary design.
- **Four-place** multi-purpose version "probably" will also be available by eventual rearrangement of the CL-41's interior. Such modification would make the airplane suitable for a variety of applications, including high-speed transport of important officials, also possibly as a light jet executive transport for businessmen.

CL-41 project marks the first airplane designed and built from scratch by the Canadian manufacturer, a subsidiary of General Dynamics. Hitherto, its production has been concentrated on license-building of other manufacturer's airplanes, such as the North American F-86 series, Lockheed T-33, Douglas DC-4 and most recently extensively redesigned versions of the Bristol Britannia, both piston and turboprop models.

Indications are that Canadair is seeking a wide market for its CL-41; its full-scale mockup has been checked not only by Royal Canadian Air Force personnel but also U. S. Air Force and Navy. Also, the company notes that the airplane's spin and recovery characteristics are designed to satisfy both U.S. and British criteria, which differ appreciably.

Basically, the CL-41 is a low-wing tricycle landing gear configuration, its outstanding external feature being a T tail. Forward of the tail, the airplane closely resembles the Cessna T-37A jet trainer for USAF in external appearance.

A single turbojet, of the latest lightweight design and low specific fuel consumption, developing approximately 2,000 lb. thrust, will be utilized indicat-

SIDE-BY-SIDE SEATING will be used to permit close coordination between instructor and student. Cockpit features will include pressurization and ejection seats.

ing the General Electric J85 or Fairchild J83 are strong contenders.

Measuring 36 ft. 4 in. span; 31 ft. 11 in. length and 9 ft. 6 in. height, the CL-41 will have a wing area of 220 sq. ft., a wing loading of 28.4 lb./sq. ft. and power loading (static) of 3.13 lb./lb. thrust. Designed gross weight is 6,250 lb.

Performance characteristics are forecast as: 1,000-ft. takeoff ground run; 1,700-ft. ground takeoff run over a 50-ft. obstacle. Stalling speed, at intermediate weight, would be 62 kt.; maximum speed at military power at intermediate weight is planned at 400 kt. and maximum speed at continuous power at intermediate weight as 388 kt.

Fuel Load

Fuel load of approximately 2,000 lb. will be provided, giving the airplane a two-hour flight training cycle at sea level without refueling. At altitude, with fuel reserve of 10% the CL-41 would have a range of 800 nautical miles at an average speed of 300 kt.

Cockpit is planned to incorporate modern combat type equipment, including ejection seats, jettisonable canopy sequenced into the seat ejection system, cabin pressurization, two complete instrument flight panels and birdproof windshield.

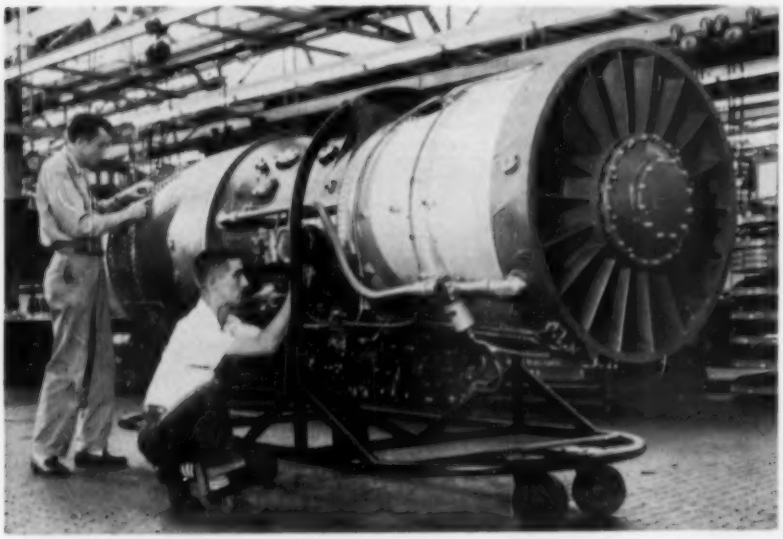
Overall director of the project is W. K. Ebel, Canadair vice president-engineering; and E. B. Schaefer. E. H. Higgins is CL-41 project manager and F. C. Phillips is project engineer.

PRODUCTION BRIEFING

Magnaflux Corp., Chicago, Ill., says it has perfected a honeycomb inspection method. Method, called Bondcheck, is accomplished by first spraying on a special liquid and then applying infrared heat. Heat causes tiny red particles in the liquid to be thermally transported by Brownian movement to positions over the core joints. In a few seconds a well defined hexagonal pattern coinciding with the honeycomb core underneath is visible on the skin surface. The process works best on resistance-welded metal cores; not at all on resin-bonded non-metallic cores.

General Electric Co.'s Small Aircraft Engine Dept., Lynn, Mass., says its T58 turboshaft has successfully passed the 150 hr. model test and has been officially accepted by the U. S. Navy. The T58 produced 1,065 hp. with 0.655 specific fuel consumption for the official test, bettering the original performance guarantees, GE said.

Contractors who have been using USAF's Arnold Engineering Center's "Hot Shot" tunnel (AW Sept. 24, 1956, p. 67) are Bell Aircraft, Ramo-Wooldridge, General Electric Co., Avco and Lockheed Aircraft Corp. Lockheed is using the tunnel for its Navy Polaris missile. GE, Avco and Ramo-Wooldridge are undoubtedly using the hypersonic tunnel for nose cone re-



J75 Turbojet Passes Company Tests

Non-afterburner model of Pratt & Whitney 15,000 lb. thrust J75 turbojet engine met or exceeded all company performance estimates and guarantees during tests at the Naval Air Turbine Test Station, Trenton, N. J. Engine, tested under all pertinent altitude and speed conditions, is first aircraft engine to have its performance guaranteed under actual altitude operating conditions and the first to have actually met such guarantees, the company said. Engine is scheduled for Republic F-105, Convair F-106, Chance Vought F8U-3 and Martin P6M.

Test Engineering at Marquardt

by
Roy E. Marquardt
President

Unique among air-breathing engines, the ramjet cannot run independently on the ground. Because ramjets depend on their velocity through surrounding air masses for compression of combustion air, intricate test facilities must be provided.

Marquardt Jet Laboratory simulates these high-speed, high-altitude flight conditions during ground testing. A USAF facility, combined with special USN test facilities, MJL is one of the most extensive in existence today. Valued at $18 million and occupying 8 acres of land, this dynamically functional engineering tool minimizes the number of costly trial and error flights of new engines.

Complex test cells, with associated instrumentation and computers, permit sea-level and altitude testing of full size and test-scale models. In our two sea-level test cells, high pressure air is directed over the test engine through subsonic, sonic, and supersonic nozzles, and exhausted to the atmosphere. Turbojets are ingeniously utilized in two full scale engine altitude test chambers to simulate heated and rarefied air conditions encountered by high-flying supersonic ramjets.

Special configurations in both sea-level and altitude cells permit angular motion of the free jet nozzles. This allows evaluation of the effects of varying angles of attack likely to be encountered by operational engines.

A new production acceptance test facility now being built in conjunction with our Ogden production plant will greatly supplement the up-to-the-minute equipment furnished the Marquardt Test Team.

Within this Division, engineering openings exist for:

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Pictured above: Leigh Dunn, Chief Engineer, Test Sub-Division
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how specs have changed!

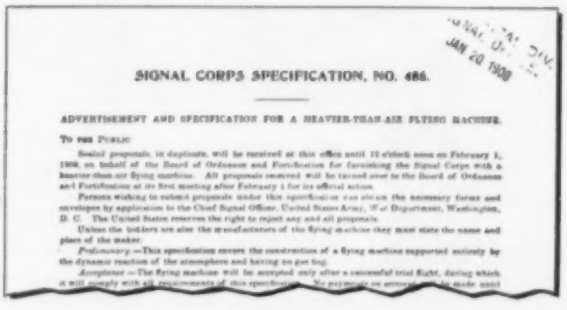
On December 23, 1907, the "Original American Army Contract for Aeroplanes" was issued. Specification Number 8 states:

> **"It should be so designed as to ascend in any country which may be encountered in field service. The starting device must be simple and transportable. It should also land in a field without damaging its structure".**

That was a pretty tough problem in 1907. As planes took off and landed at higher speeds, the problems got tougher. Some of the answers have come from L·O·F. Example: Development of *Electrapane*® for windshields to give pilots perfect visibility despite frigid flying conditions. *Electrapane* is in Canadair's "CL-28", Lockheed's "C-130", Douglas' "C-133" and Boeing's "KC-135", among others.

If you have any question concerning the latest developments in aircraft glass, send it to Aircraft Division, Dept. 73117, Libbey·Owens·Ford Glass Company, 608 Madison Avenue, Toledo 3, Ohio.

In any event, write for a copy of *The Original American Army Contract for Aeroplanes* suitable for framing.



SIGNAL CORPS SPECIFICATION, NO. 486.

ADVERTISEMENT AND SPECIFICATION FOR A HEAVIER-THAN-AIR FLYING MACHINE.

To the Public

Sealed proposals, in duplicate, will be received at this office until 12 o'clock noon on February 1, 1908, on behalf of the Board of Ordnance and Fortification for furnishing the Signal Corps with a heavier-than-air flying machine. All proposals received will be turned over to the Board of Ordnance and Fortification at its first meeting after February 1 for its official action.

Persons wishing to submit proposals under this specification can obtain the necessary forms and envelopes by application to the Chief Signal Officer, United States Army, War Department, Washington, D. C. The United States reserves the right to reject any and all proposals.

Unless the bidders are also the manufacturers of the flying machine they must state the name and place of the maker.

Preliminary.—This specification covers the construction of a flying machine supported entirely by the dynamic reaction of the atmosphere and having no gas bag.

Acceptance.—The flying machine will be accepted only after a successful trial flight, during which it will comply with all requirements of this specification. No payments on account can be made until

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entry studies for their USAF ICBMs. It is not known what Bell is using the facility for.

"Operation Hourglass," Allison Div., General Motors, got under way recently with a YC-131C equipped with Allison 501-D13 turboprop engines and Aeroproducts 606 four bladed propellers. The engine-propeller combination is the same that will be used on the Lockheed Electra commercial airliner. Objective of "Operation Hourglass," said Allison, was to obtain 1,000 flight hours in the shortest possible time under both military and commercial transport conditions. Allison hopes also to demonstrate the value of converting existing aircraft such as the Convair 340 to its gas turbines.

Beryllium may be the answer to need for higher performance missile structural materials if it can be produced in useful quantities at economical prices, according to Maj. Gen. William O. Senter, USAF procurement chief at Air Materiel Command headquarters, Dayton, Ohio. Beryllium is six times stronger than steel on a strength to weight basis, weighs about a third as much as aluminum and will withstand 1,200F temperatures, according to Senter. Reasons why beryllium is not now being used include its high cost ($200 per pound against $20 for titanium and $2 for stainless steel) and beryllium's toxic and abrasive nature.

Boeing Aircraft Co.'s Bomarc missile development engineers are using polyethylene plastic pellets shot from a .222 rifle to simulate effect of a supersonic missile flying into rain storm. Depending on how much powder charge is used, the pellet's speed varies from 2,200 to 4,500 mph. (Roughly Mach 3-6). Its line of travel is from the muzzle, through a silencer, through a small hole in a steel-plate guard, through two pieces of paper used to measure the pellet's velocity, and through an open oven door into an oven where the target, a sample of the Bomarc's skin, is being heated to 400F. Length of flight is seven feet. Boeing said the plastic raindrops disintegrate on impact, leaving only a pock mark to show where they hit.

Stanford Research Institute, Menlo Park, Calif., has attempted to offset the adverse effects of nuclear radiation upon epoxy bonding adhesives by introducing its "antirad" additives and scintillator compounds. Research which is being carried on with USAF funds has shown that radiation damage to epoxy resin takes two forms: cross-linking to form supermolecules and cleavage or rupturing of desirable bonds of the polymer.

FASTENER PROBLEM

Miniature right-angle stop nut for cover hold-down saves space and weight on avionic unit

This is United Control Corporation's advanced Master Warning System Control—designed and developed to reveal any aircraft system malfunction. It is used on the supersonic Republic F-105 Thunderchief and like all key avionic components this equipment must be lightweight, compact and highly dependable.

THE PROBLEM: How to attach a dust cover securely, with provision for easy removal for inspection and a high degree of fastener re-usability. Yet this fastening job had to be done within minimum weight and space allowances.

THE SOLUTION: A miniature, right-angle basket nut—Type A27M—especially developed for blind mounting applications, with a high re-use nylon locking insert, provided the answer. A built-in "float" permits the nut to be self-locating—to compensate for a reasonable amount of misalignment between nut and screw. If high temperature had been a problem ESNA could have supplied Type LHA27M which has the same features as Type A27M plus an alternate type of locking device which withstands heat up to 550°F.

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ESNA's line of right-angle basket nuts, shown above in actual size, includes the standard size A27 for applications where space is no problem, the miniature A27M, and the high temperature miniature LHA27M.

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2330 Vauxhall Road, Union, New Jersey

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☐ I enclose a drawing of our product. What self-locking fastener do you suggest?

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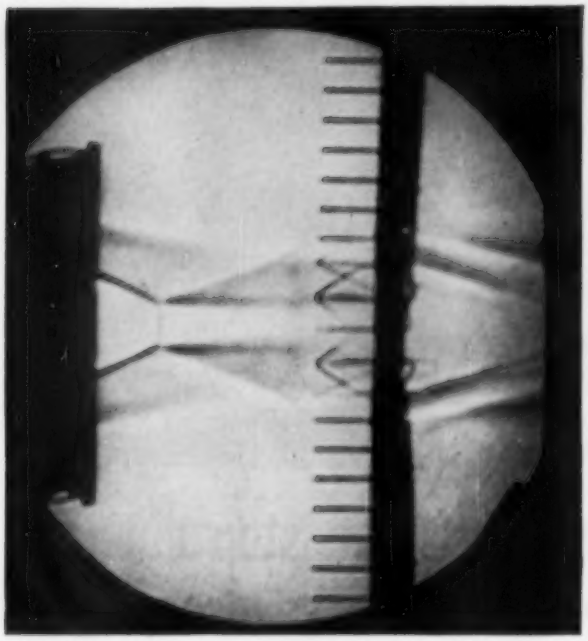
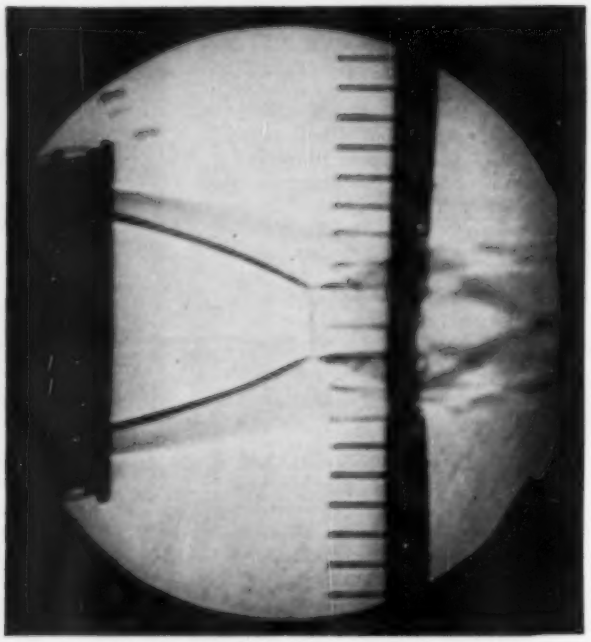




SCHLIERAN photos show compressed air released from model engine thrust chamber to simulate flows at altitude. Approximate sea level pressure (left) with supersonic exhaust in tight core. Photo (right) represents 20,000 ft. where center core begins swelling.

Rocketdyne Develops Missile Engines Now,

VACUUM wind tunnel, where the other photos on the page were made, is operated for Rocketdyne to test rocket engine components. Technicians Glenn Rowley and Archie Smith are fitting part to test equipment. Rocket engine bellmouth nozzle at right is awaiting its performance tests. Low pressure tunnel is a preliminary design tool in which various nozzle shapes are investigated for exhaust pattern, velocity.

By Richard Sweeney

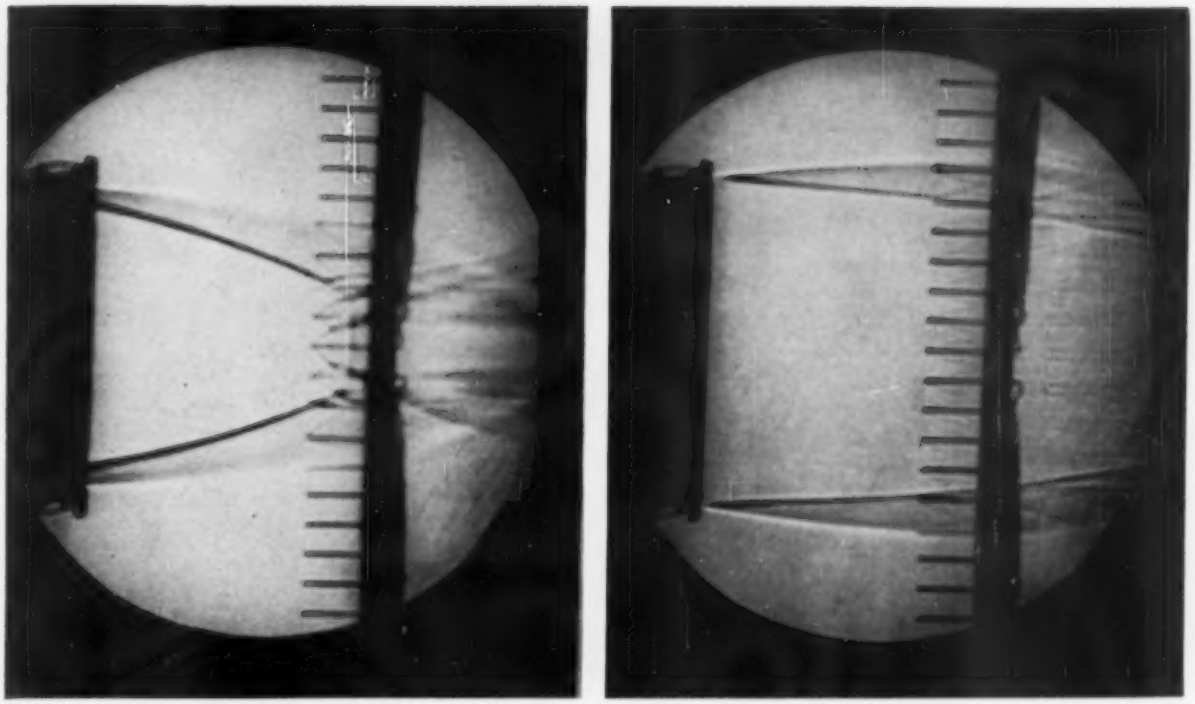
Canoga Park, Calif.—Destined to play a key role in ballistic missiles today and space vehicles tomorrow, high energy propulsion systems are being advanced through research and test at the extensive facilities of North American Aviation's Rocketdyne Division here.

While large liquid propellant rocket engines for Atlas, Thor (see cover) and Jupiter are being thoroughly refined as experience is gained in preliminary design, manufacturing and test techniques, other schemes for a wide variety of applications are being conceived, analyzed, evaluated on paper and translated, in some cases, into hardware.

Rocketdyne pre-eminence in the large liquid propellant field stems from a North American corporate decision in 1945 that missiles were to be important in future defense plans and therefore the company should immediately establish itself in the field.

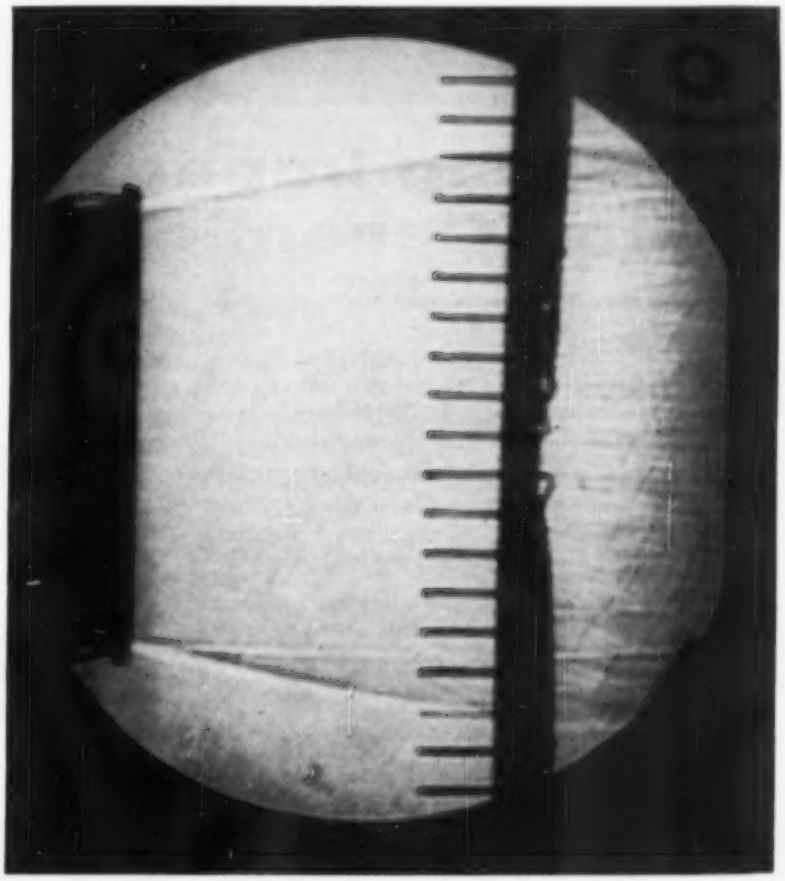
One of several companies awarded a study and research contract on a missile system, North American established 12-man aerophysics group in July, 1946. Dual company purpose was to work on this contract, and to develop simultaneously across-the-board missile capability.

Following a company decision that



FLOW patterns at 30,000 ft. (left) and 50,000 ft. (right) show continued expansion. Air rake, where shock waves are forming, measures exhaust velocity. Tunnel pressure in last photo is at near vacuum of space and gases have expanded beyond optimum point (below).

Studies Space



three major areas of supersonic aerodynamics, inertial guidance and large liquid rockets, needed study, the original aerophysics unit gathered and digested all available data on German rocket work, proceeded from there into specialization according to system. This resulted in formation of:

- **Rocketdyne**, for propulsion systems.
- **Autonetics**, for guidance, electronics systems.
- **Missile Development Division**, (MDD) for overall missile systems.
- **Atomics International**, which got a start in early work involving feasibility of nuclear power for an airborne weapon system. Study showed this particular application unfeasible, but in the course of investigation, a competent staff and bank of knowledge were assembled and the group stayed intact, went into commercial nuclear work.

Under present organization, divisions operate as entities according to their specialties. Typically, if Missile Development Division conceives a missile system, Rocketdyne bids against all comers for the propulsion system, Autonetics likewise faces open competition for guidance and electronics contract. By same token, divisions are free to bid on contracts with other principal weapon system contractors.

Division philosophy, structure and

Surviving Impact is an Eimac Ceramic Tube Extra

Aeronautical electronics demands extras from vacuum tubes. Among them is the ability to withstand heavy impact without impairing electrical characteristics. The photograph dramatically shows what happens to a 250 watt glass envelope tube and an Eimac 300 watt ceramic tube when both are dropped from a height of seven feet. The ceramic tube "took it."

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D-C Screen Voltage	300	300	400
D-C Grid Voltage	—250	—250	—
D-C Plate Amperes	.250	.200	.250

	FM	AM	SSB
Plate Dissipation, watts	300	200	300
Screen Dissipation, watts	12	12	12
Grid Dissipation, watts	2	2	2

management policy, Rocketdyne officials believe, is the key to the organization's present leadership in large liquid rocket engines which are used in USAF, Army and Navy projects. Rocketdyne achieved full division status in 1955, but had been developing toward this in management and other necessary techniques during preceding 18 months.

Division's Freedom

Division management gets policy guidance from corporate officials, is autonomous in day to day operations. Profit and loss are up to division management. Division has capital funds at its disposal sufficient for normal operations.

Internally, Rocketdyne is separated functionally. Basic units are administrative, plus services, engineering and manufacturing. In line with procedures becoming standard, quality control is a line function rather than a part of any other group.

Engineering is broken down into preliminary design, design and development, test operations, research and administration.

Research, under Director John Tormey, is planned and directed rather than basic, is aimed toward applications in general, not always specifics. Operating, according to Tormey, "one step behind true basic research," the section takes discoveries of such basic research centers as Bureau of Standards, seeks usability of their discoveries. Being closely followed today are bureau work in cryogenics and free radicals.

Rocketdyne trend today, Tormey says, is gravitating toward physics, away from chemistry. Five years ago, physics per se received no attention in the section, now is firmly established as integral part of research work.

Much of section's efforts are devoted toward combustion, heat transfer, propellants. The researchers have a hydrocarbons laboratory equal to or better than those maintained by most oil refineries.

Newer Fuels

While work in hydrocarbon fuels currently receives greatest attention, new areas are not neglected. Research section currently has elected to follow the free radical path looking toward the next generation of rocket engine fuels.

Work is being accomplished in heat transfer associated with ionization in current type engines, as well as in heats and pressures, fields of dissociation.

A problem for researchers, Tormey points out, is the facilities and equipment necessary for ionization class research. Since rocket engine work is comparatively new, Rocketdyne research frequency has to design equipment and facilities aimed at its own

Lockheed's F-104A Starfighter

Reaching for the Stars

With its new air scoop design, high, T-shaped tail and knife blade wings (just 21 feet, 11 inches from wingtip to wingtip), Lockheed's F-104A Starfighter is America's fastest fighter. It flies so high and so fast that pilots almost feel they are running out of sky room.

The Starfighter performs near the fringe of today's understanding of aerodynamics, and incorporates in its design unusual features suggested by the most recent developments in the field. Because of its advanced design, many new questions arose . . . questions which were answered through extensive wind tunnel testing.

CWT—the Southern California Cooperative Wind Tunnel—played a vital part in this testing. Throughout its development, many hours were spent by CWT's staff in gathering data on the F-104A's aerodynamic behavior. The success of this work is reflected in the Starfighter's performance record.

The CWT is responsible for testing many of the nation's most important aircraft and missiles. In addition to its five owner companies, CWT also serves other leading aircraft firms and government agencies.

If you would like more information regarding the CWT'S facilities, or information regarding employment, please write us.

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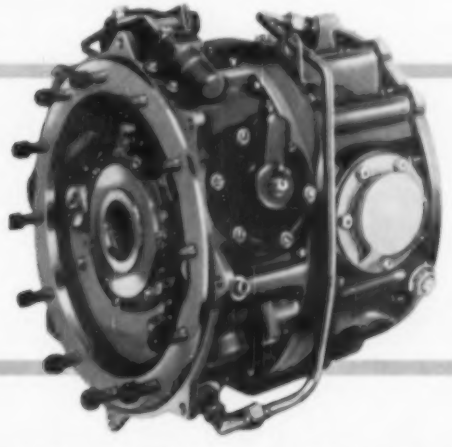

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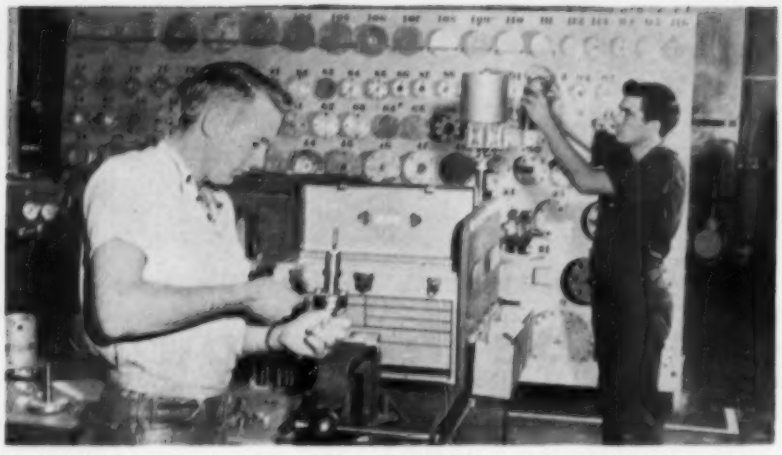
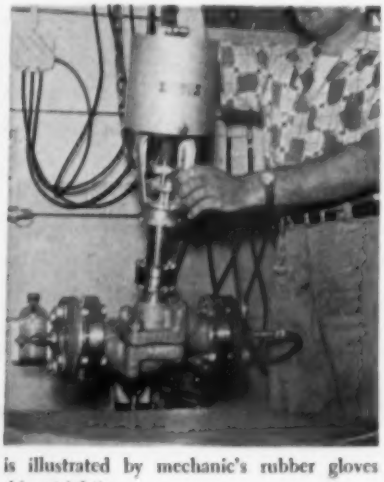


VALVES for liquid engine rocket motors are checked out at Rocketdyne's Santa Susana Equipment Laboratory before motor is fired. Mechanics (above) are running a check.



CARE with which components are handled is illustrated by mechanic's rubber gloves (left). Valve is being set in test bay before checking (right).

particular requirements, imposing a need for "talent on talent," that is having people skilled enough in their own fields to be able to design equipment for new or unfamiliar work while simultaneously having personnel enough to accomplish current work.

Now under construction at the Propulsion Field Laboratory at Santa Susana, about 10 mi. from present offices, is a half million dollar research building.

One major problem encountered in Rocketdyne research, according to Tormey, is in the mathematical abilities of those joining the section. Primarily the difficulty is the schools, which still teach the same mathematics for engineering and science courses taught years ago. An incoming graduate must first advance from his school mathematical base to the higher base in current industrial use.

An example, Tormey says, is use of probability theory which many new engineers do not understand or have faith in, to replace expensive tests and laboratory investigations. Due to financial considerations, this theory has to replace experience in rocket engines to an extent that dictates engineers must have faith in it and use it even though they are unfamiliar with the theory.

Concerning money for research, Tormey declares there is no dearth at all of financial support for worthy projects. Ideas for research work must have merit, and for these, there are ample funds. However, one catch is that to sell the ideas, researchers sometimes seem to need the answers in order to sell investigation of the problem. Majority of research proposals come from company to the military, Tormey says, but sometimes the military approaches the company to tackle a particular task.

When a research fields looks promising, according to Tormey, yet is not far enough along to be made into a firm proposal for research project contract to a service, company funds are available to bring the work to the stage where it can be wrapped into a proposal. Here again, he points out, proposals have to be fairly well founded before much outlay will be approved.

Tormey indicated that Rocketdyne has conducted extensive study with solid propellant rocket engines, but believes two factors dictate staying with liquid propellants for large engines: the inherent flexibility of liquid propellant engines and a narrowing of the complexity gap as solids reach for higher thrust levels and sufficient flexibility to make them operationally worthwhile.

Preliminary Design

Scope of Preliminary Design, under George Sutton, is wide. Activities include:

- **Commercial product** studies.
- **Propulsion system** analyses, determining whether rocket propulsion is best for a particular application. Rocketdyne's standing in the field is such that customers frequently consult Preliminary Design people when formulating requirements for a particular application.
- **Preparation** of proposals for designs.
- **Intense studies** of nozzle, combustion chamber configurations. Current bellmouth on nozzles in service engines, replacing former cone, is one application of this work.
- **Non-missile applications** such as new Navy aircraft booster engine (AW Nov. 18, p. 23).
- **Advanced studies** such as those culminating in the Snooper space vehicle with ion propulsion, currently believed the most logical first step in space-tailored propulsion systems (AW April 8, p. 27).

An area where preliminary design finds a heavy work load is in propulsion system control, with respect to the interplay between engines and guidance systems.

Alternate Approaches

Two conditions dictating different approaches and degrees of sophistication in preliminary design estimates are whether a missile is required to reproduce a trajectory, follow the same general path each flight, or whether it has a strong trajectory control itself. First condition requires small variations in thrust while second needs wide range to fulfill its mission.

Completing those parts of propulsion systems which translate guidance system signals into changed thrust vectors requires detailed analysis covering all aspects of operation. Typical is the large knuckle joint and actuating struts which are the basis of a gimbaled rocket engine.

One development the section produced in its work is a double ended rocket motor for measurement of thrust

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variation. Different thrust chambers and nozzles of varying configuration are evaluated on the equipment.

Another preliminary design tool is the low pressure tunnel wherein various nozzle shapes are investigated for exhaust pattern, velocity. Low chamber pressure prevailing during nozzle discharge simulates flow patterns at varying altitudes from sea level to stratosphere.

One of Rocketdyne's biggest assets is its Propulsion Field Laboratory, 1,700 acres in the Santa Susana Mountains, not too far from the main Canoga Park Plant, where terrain is well suited to large engine test stands.

Early Tests

Begun in 1947, when North American acquired a few hundred acres, Propulsion Field Laboratory had its first firing of a large engine thrust chamber and injector assembly in January, 1950. Personnel then numbered 15, tests were at the rate of two or three per week, and after each firing a critique was held at which all observations of everyone present, from engineer through test stand mechanic, were recorded.

As firings began, Rocketdyne faced a community relations problem in adjusting the large San Fernando Valley population to the new window shaking sounds. Today the sounds are largely ignored. Although Rocketdyne's personnel have become fair experts in meteorology as it affects firings and sound paths, freak atmospheric conditions occasionally will bounce sound to distant residential areas, creating an uproar.

At the start of the Propulsion Field Laboratory, North American built stands with its own money, with part of the equipment for the stands paid for by USAF. Later, North American bought more land and USAF built stands for Rocketdyne to operate.

Nineteen Stands

The test laboratory now has 19 test stands in operation, some with more than one firing position, plus three component test laboratories for gas generators, turbopumps, vernier engines, starting systems. A fourth component laboratory is under construction. Currently, thrust chambers are tested on stands and at one components laboratory. The new laboratory under construction will be able to test thrust chambers, even large ones and will free some stands for conversion to complete engine test rigs.

In addition to those at Propulsion Field Laboratory, Rocketdyne also operates test stands at Edwards Air Force Base, Huntsville, Ala., and its Neosho, Mo., plant. Edwards stand does development testing. Huntsville is used for production testing, and Neosho, where Thor and Atlas engines are being produced, does strictly production testing.

Both production and development testing are done at Propulsion Field Laboratory.

Guiding philosophy of development test is to insure that a finished propulsion system is homogenous, with all components developed to a state matching the requirements and each other.

Production testing subjects engines to a required number of starts, the critical part of rocket engine operation, and run times are sufficient to disclose defects without encroaching too greatly on service life.

Facilities at Propulsion Field Laboratory include provisions for systems test wherein simulation of flows is used. Components are tested first, then assemblies, then engines. For realistic conditions, liquid nitrogen is used on one side of a run when JP-4 is cycled through, and the opposite run has water substituted for fuel when liquid oxygen is run through.

Three test stands and their control center are grouped to form an area. Areas are located in natural pockets to isolate them from one another, take advantage of rock formations to deflect sound. Under area optimization, central fuel tanks and liquid oxygen storage

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is used at each area. Propulsion Field Laboratory has a liquid oxygen plant, trucks the oxidizer from plant to each storage, then pipes it from storage to test stands as required. Fuel trucked in from remote depots is handled similarly in that trucks deposit it at area storage tanks and it is piped to stands as needed.

Helium is stored at several strategic locations from which it can be piped to more than one test stand area.

Opportunity Basis

Although general test programs are outlined by an advance planning group, testing at the stands is conducted on an opportunity basis to some extent. Since a run may be scheduled on one stand in an area only to have a flaw delay firing for a time, if another stand in the same area is close to a firing, it will go ahead. The earlier scheduled stand will wait, rather than tie up the entire area while problems are solved. Since areas must be cleared of all but control center personnel, time is lost for mechanics and technicians who are sent back to a roadblock that is formed when a firing is close. To use the time, roadblock schools are being formed to upgrade general knowledge of workers in the fields related to their work.

Safety program gets constant plugging. Workers are kept fully aware of hazards accompanying materials they work with, resulting in an excellent accident record despite nature of the work.

To obtain bonuses from normal test work, rocket exhausts have been utilized in a number of studies. One was on effects of exhaust on radar and telemeter waves which virtually have to pass through exhaust at some point in flight. Some attenuation was found, but less than had been anticipated. A second investigation was on nose cones.

Rocketdyne test people have had to design much of their own specialized equipment, such as the 60-ton flame deflectors and the intricate water injection system which protects them during an engine run. They have adapted items not usually associated with flight in any phase to their own purposes. One is a 1,200 v. d. c. generator formerly used on an inter-urban trolley line, built in 1915. The same man who ran it for the transit line operates it for Rocketdyne. Generator powers three 1,300 hp. World War II submarine motors. Combination drives propellant turbopumps at operational speed without resorting to gas generators for each test.

Another special unit developed by Rocketdyne is a combustion-stability monitor. Investigation showed the best human engineers took .6 sec. to cut off an engine after seeing malfunction, assessing it and actuating cutoff button. Often, before a malfunction was visible, flame deflectors were burned. Combustion stability monitor counts vibrations over finite time periods, 20 milliseconds, and if the number is out of preset bounds it automatically cuts the engine. It is insensitive to vibrations in amplitudes extraneous to combustion stability.

Taking further precautions during each run, a number of mechanics with engine cutoff switches are posted at key parameter dials plainly marked, and should limits be reached or exceeded, cutoff is the rule. Conservatism is the theme to protect expensive engines, stands, facilities and equipment.

Of the 1,200 people in test operations, 30% work in instrumentation, the biggest problem area of the testing organization. Majority of attention is paid to routine test instrumentation, but a number of people are engaged in instrumentation research.

A basic need for routine work is to determine accurately performance of individual engines so that data on their particular characteristics will accompany the engine into service and permit accurate flight programming in operational units.

In routine test instrumentation, temperatures in the low range are the current headache in liquid hydrogen work; measurement to $\pm\frac{1}{4}$ deg. accuracy is required but better accuracy is desired.

Instrumentation people would like to measure high and low temperature gradients to $\pm.2$ deg. over a 30 deg. gradient. Since they do not have the equipment for real reliability and response temperatures, it is a problem to get readings on a steady state basis.

High temperature areas fall in gas generators and turbopump turbine inlet temperatures as well as thrust chambers. While generators and pumps are expected to remain stable for some time, they face much higher temperatures as hydrogen-fluorine enter the propellant picture in the drive for higher specific impulses. Currently a full scale program has been initiated to determine what measurement method will be used in these over-5,000F regions. A literature search is under way, a small start made at theoretical analysis.

Temperature Problem

Mass flows, where temperature plays a part, is a severe problem. Accuracy here now is of the order of 1-2%, but confidence level in this degree is low and even greater accuracy is greatly desired. Temperature transients are the bugaboo, and while frequency response up to 10,000 cps. is obtained, accuracy of magnitude of variations is the weak point.

Volumetric flows, including transients, are under good control with turbine flowmeters, to $\pm.2\%$.

Air transmitted pressure variations, acoustical noise, are trouble spots in obtaining high frequency data such as accelerations and pressures near the engine while it runs, since rockets put out more than 150 db. Concrete blockhouses, acoustically insulated, are used.

Instrumentation line loss and variations are minor problem, with 10 years experience to draw on. However, malfunctions due to weather penetration of conduits still occur.

Routine test instrumentation is now being centered about the Instrumentation Digital On-Line Transcriber, essentially a high speed analog to digital coverter which takes raw data from test stand sensors, processes it for IBM 704 computer on tape, to provide com-

Rocketdyne: Key Personnel, Facilities

General manager of Rocketdyne is Samuel Hoffman, long time rocket engineer, and William Guy is assistant general manager. Guy joined North American after leaving Wright Field following World War II.

Chief engineer is T. F. Dixon, assistant chief engineer is Paul Vogt. Under this section are Preliminary Design, George Sutton; Design and Development, W. J. Brennan; Test Operations, William Cecka; Research, John Tormey.

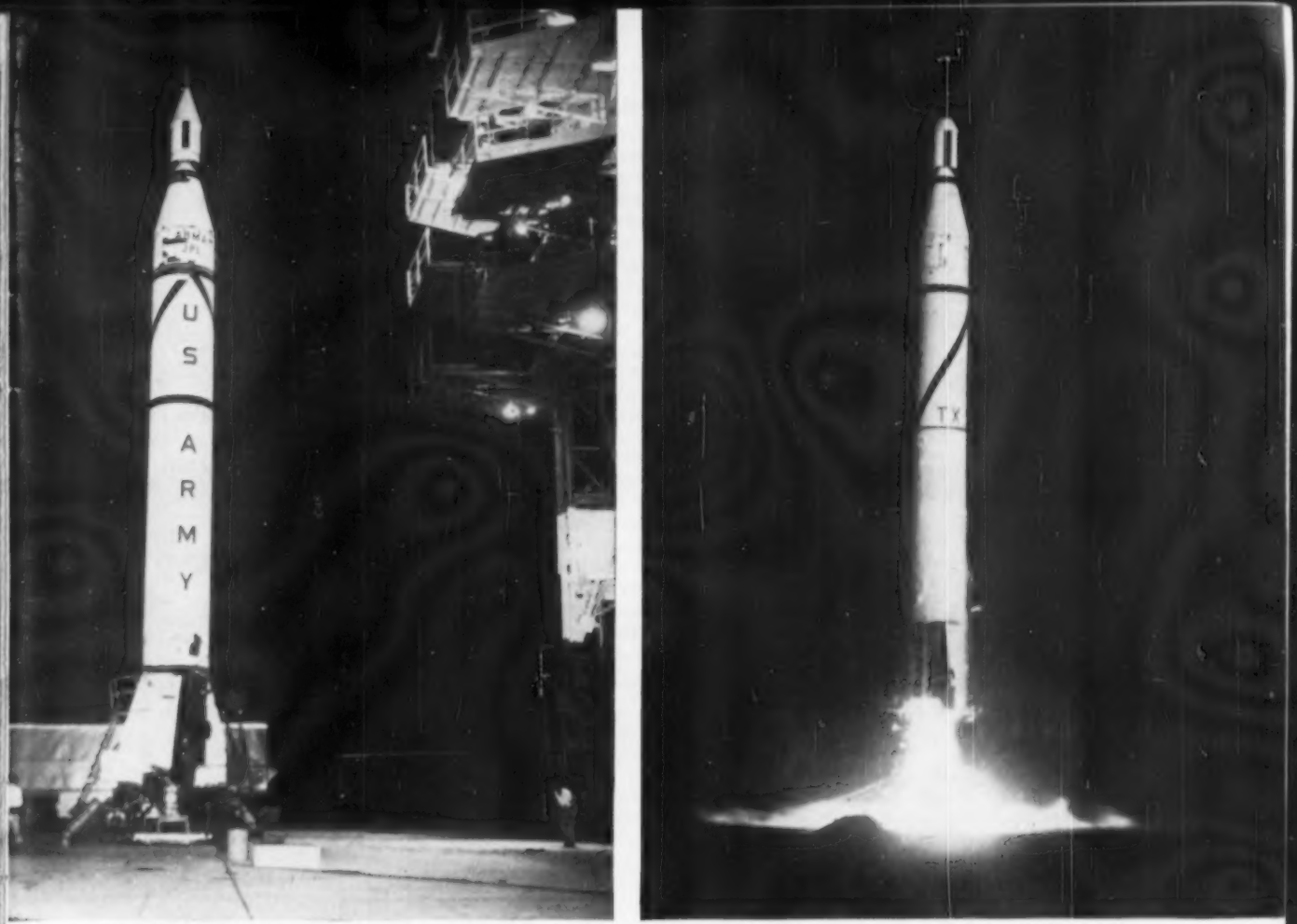
Manufacturing is headed by Ross Clark, Quality Control by Robert Heath, Service by James Broadston.

J. P. McNamara heads the Neosho plant, where 600 are employed, building engines for Atlas and Thor in 228,000 sq. ft. of plant on a 200 acres test facility.

Canoga Park main facility has 316,000 sq. ft. There also is a 550,000 sq. ft. engineering building, an 84,000 sq. ft. material building. Entire division utilizes 900,000 sq. ft. overall.

Employment runs about 10,000—4,000 in engineering, 5,000 in manufacturing, plus 334 in service, and assorted activities. Of the 2,500 employed at Propulsion Field Laboratory, 1,200 are in engineering; remainder are technicians, mechanics or in services.

The division employs about 2,000 graduate engineers and scientists.



ROCKETDYNE developed engine for Army's Redstone missile, here shown as first stage of Jupiter C test vehicle being fired at Cape Canaveral, Fla. Nose cone successfully survived re-entry, Department of Defense claimed. Firing was made Aug. 8.

puted data faster than it presently is available. Plans call for nine of these computers to be operating by next June, with at least one per control center. Since the computer is at Canoga Park, the original intention was to microwave data back to Canoga Park so that engineers could be looking at computed data while a run was still in progress. Presently, tapes are taken to Canoga after runs, and some difficulties have been encountered with the instrumentation digital on-line transcriber.

Test engineer in control center would also have the transcriber readout samples available to him in addition to current type instrumentation now in use. New component test lab under construction is designed around the instrument digital on-line transcriber and will have backup of some standard gages.

Most instrumentation on test stands consists of commercial items. In many cases they were originally designed around rocket engine requirements, a large majority around Rocketdyne's applications, and have become standard items.

In addition to a combustion stability monitor, an outstanding Rocketdyne development is in a capacitance and variable inductance gage for accurate measurement of use rate and quantity in tanks of unique fuels and oxidizers. Signal output has been put in digital form, but the predominating output is analog.

Reliability Check

Statistical analysis of measurement performance is used to obtain reliability indication on data. Analysis is continuous, based on new calibration run information which is constantly fed in as new data is integrated, and oldest data is displaced. Small sample size technique is used and a time-history plot made. Instrumentation people can indicate to test engineers that data, based on recent calibration runs and statistical analysis, will have a certain bandwidth of error. System serves to check reliability of measurements as well as acting as a guide for upgrading accuracy.

Most critical measurements are now obtained to $\pm 1\%$, but the desired figure is $\pm \frac{1}{2}\%$. A goal is thrust measurement to $\pm \frac{1}{2}\%$ at a 95% confidence level, and standard procedure is to adjust the accuracy to maintain the confidence level.

Current standard is $1\frac{1}{2}\%$ accuracy on an average of all pressure measurements, and here, less critical pressure measurements accuracy is allowed to decay while effort is directed at upgrading accuracy of most critical measurements.

Instrumentation greatly needs, according to John Witherspoon, instrumentation research chief, a new and correct set of standards. He points out the interplay of thrust measurement with a device, compared with thrust measurement on a test stand, and final thrust, that of engine in flight under widely varying environments.

Current systems base a dynamic condition on a static standard, he says, and while new aerothermodynamic theory is becoming available to determine thrust and other parameters on a truer basis, there are no instruments to check the theory or other standards of measure in the new area.

Needed is development of new instruments designed especially for this new area, and work is under way at

Rocketdyne to develop instruments which will enable researchers to understand the phenomena, rather than development of instruments as end products.

Researchers, Witherspoon said, are studying rocket exhausts closely with adaptation of the NACA-developed spectrographic pyrometer which gives a direct measurement of brightness temperature. They have made laboratory studies of flames with varying cross sections of temperature configuration, calculating what these would mean in an engine on a test stand firing. Work is progressing in study of rocket exhausts in the visible and near ultra violet spectra.

Ultimate aim of the variety of flame research projects is development of instrumentation which can analyze the rocket exhaust and yield realistic thrust measurement on a correct standard base, for the exhaust is, in essence, the thrust. Currently, engine thrust is absorbed by highly accurate strain gage type load cells which are shelf items.

Exhaust Data

Their data so far are yielding much knowledge on the nature of rocket exhausts, and on the basis of spectrographic work, they have more confidence in the temperature measurements now being made.

Working in test programs specifically designed to provide data they need in research work, doing more statistical analysis of data presently acquired, researchers feed in known statistical variations in measurements so that overall development of engines can be speeded. Their work has included full analysis of injectors, and small variations in test data, properly analyzed, indicated the preferable design.

Under way is an intense effort to find out why rocket engine combustion is unstable, and what part or component is responsible.

They are working toward better analysis of the thrust level increase curve slope, since by understanding the slope, they will be able to control it. A goal is automatic throttling of an engine in flight to produce required thrust accurately.

Over the years, significant gains have been made in pressure measurements. Biggest single step is the current method of measuring pressure at the thrust chamber wall, which entails having sensitive equipment operating in contact with gases which are at more than 5,000F.

Researchers are able to make these measurements without distortion in the amplitude, frequency or phase, essentially the wave shape of the reading, between the gas pressure source and sensing device in the chamber wall. This way, they need not worry about distortion from making pressure measurements at a distance from the pressure source.

While the instruments do not give a highly accurate direct reading, enough is known about the instruments that accurate corrections can be applied.

Adding mechanical and electronic devices to improve measurements, they have developed a proprietary system known as DADEE which compensates for inherent mechanical and electrical distortions present in sensors.

Manufacture of rocket engines is accomplished 90% with standard machine tools, the majority of specialized equipment being used in inspection.

One major special setup is used in injector head drilling, extreme precision being necessary in this operation. Changing technology limits injector setups to a one-at-a-time basis.

Processes used include forging, stretch press and hydropress forming, welding, brazing and machining.

Forging and Forming

Thrust chambers and nozzles are forgings, machined to final dimensions. Gas generators and turbopumps involved formed exterior sections, machined inner rotating parts. Rocketdyne has designed special machines for its forging and stretch press forming work.

Some semi-automation is used, one process involving a multiple head Bullard cutting machine which operates electronically with sensors picking up signals from positioning indicators mounted on a cable.

Most elaborate setups and machines are involved in turbopumps. However, these are the most stable production parts, due to fewer engineering changes and the closer tolerances involved.

In the machining process, a machinist may be working on the rough stage of a part from a print which has finish dimensions. However, another paper accompanies each job onto a machine: a shop order, which specifies just how far the worker goes in his particular operation regardless of the steps called for on the print. Remainder of the work is left to be accomplished at a specified assembly point.

Assembly Technique

"Packaging" technique is used in buildup of thrust chambers, injectors, pumps, small vernier engines. Technique has rough machining accomplished on parts, then assembly work. Much welding is involved in rocket engine fabrication, using heliarc, conventional arc, spot and seam systems, and most welding is accomplished in early stages, after first rough machining.

When parts arrive at the final assembly stage for each component, roughly 80% of the work is done, remainder being in finish machining.

All components except vernier engines are fabricated at locations other than Canoga Park. As parts arrive at the Canoga facility, dolly buildup of engines is accomplished on station type production line from finished components. Only bolting needs to be done.

Development hardware is all fabricated in the conventional manner.

Due to the unique work involved in its machine operations, Rocketdyne's preference is to hire young machinists and train them to the division's particular requirements, a process deemed easier than retraining experienced machinists.

Manufacturing is equipped with a hydrostatic test facility, and engines are run through prior to sending to Santa Susana for hot firing test. Engines again are run through hydrostatic facility after return from Propulsion Field Laboratory test.

Manufacturing leaders feel that the current system is optimized, yet retains the flexibility they require.

Quality control at Rocketdyne is accomplished by inspection, with statistical methods.

According to quality control chief Robert Heath, this section's business is quality, its activity is control.

For its work, this section has a production development laboratory for special investigations. Results of investigations are fed back to the proper department for action.

Activity also includes running quality verification tests, which are essentially the exhaustive tests done in engineering qualification, plus normal functional

New Martin Division

Martin Co. has created a new division to accelerate at-the-scene arrangements for launching of the Navy Vanguard earth satellite and the Air Force Titan intercontinental ballistic missile.

G. T. Willey, the company's corporate vice president, manufacturing, will take on additional duties as vice president and general manager of the new division, according to George M. Bunker, Martin Co. president.

Division, which has not yet been named, will have equal status with Martin's Baltimore, Denver and Orlando divisions. Willey will direct all Martin activities in the Patrick AFB and Cape Canaveral area, including continued testing of the most recent version of the USAF Matador tactical missile.

According to Bunker, "The fact that this senior vice president now takes charge of our activities at Patrick is a measure of this company's determination to do its work effectively and in the shortest possible time."

tests, then a teardown of the engine and inspection for general quality and workmanship.

Quality control tests hardware to the stage where it meets the standard "the part works at all times it is supposed to." This is intended to be sufficient to eliminate random failures and yield a very high confidence level.

One of the biggest problems has been in teaching companies that make parts intended for use in rocket engine propellant systems the standards of housekeeping and cleanliness necessary for this work. Fine tolerances and high rotational speeds make any dirt an almost sure cause of a malfunction.

Newest but extremely important operating section within Rocketdyne is the service division, headed by James Broadston, the scope of which is:

- **Field service,** liaison, feedback of happenings in field for indicated action.
- **Spares management** for producer.
- **Logistic support** center for customer, which functions under contract essentially as customer representative with inside track to factory.

Compressed time schedule of weapon system development has caused virtual research and development engines to enter the field as operational units. Service has to keep these running.

While the weapon system concept calls for an overall manager, rocket engine technology indicates that no one person or group can know all about everything, that system manufacturers will be best informed on their own products for support to the prime contractor. Rocketdyne has, over its 10 years' experience in testing engines, built up a good fund of knowledge on service requirements for its powerplants.

One of the problems facing service work in rocket engines is training the customer's management personnel to think in rocket engine terms in planning, as well as training the nuts and bolts technicians on the firing pads.

Under the new concept of logistic support for missiles (AW Aug. 26, p. 26), contractors act in the area formerly occupied by Air Materiel Area. Under the concept, contractors earn a management fee for their logistics services, and Rocketdyne seeks to hold the logistics support contract for all its engines.

To get and hold these contracts, the service has to exercise management skill to a high order, be able to:

- **Crank engineering changes** and refinements into all engines on ground at minimum cost in time, money.
- **Realize and plan** accurately for number and type of spare parts necessary to support particular program throughout its life.
- **See, when program** is drawing to a close, that excess spares are inserted back in factory production line, minimize financial loss in obsolete spare parts.

Rapid Servicing

Working with engineering to insure a high degree of interchangeability in all parts, and to keep a master parts specification on all components current at all times, Broadston feels they can really speed an engine through the service process. They will be able to determine from the customer what model engine he is sending back, and what model he desires to have it modified to. Parts to accomplish the change to the new specifications can be readied while the engine is in transit. Once at the service installation, which is to have its own quarters not far from the factory, the engine will be disassembled, those basic parts needing work will be processed, the engine can be reassembled to the new model specifications, inspected and sent on its way in minimum time. Old parts are returned to the factory for remanufacture or scrapping.

USAF is inaugurating, at its Mira Loma, Calif., facility, a center to gather data on all failure modes in rocket engines. Information compiled will be for reference, will service industry as a central information agency on rocket engine problems. Rocketdyne service is contributing all its experience to aid the USAF compilation, the goal of which is upgrading all U.S. missiles.

Anti-Missile Function Consolidated by Army

Huntsville, Ala.—Separate unit to oversee anti-missile work has been established at the Redstone Arsenal. Unit, the Redstone Arsenal Anti-Missile Missile Systems Office, will be headed by Col. Matthew R. Collins who will also continue in his present position as director of the research and development division ordnance missile laboratories.

Anti-missile office will incorporate an older group—the anti-missile missile branch of Projects Management Staff of the Army Ballistic Missile Agency.

Swedish Saab-32 Lansen With Air-to-Surface Missiles

Saab-32 Lansen, Royal Swedish Air Force all-weather attack plane, is armed with Swedish-developed air-to-surface guided missiles designated Type 304. The 304, powered by a rocket motor, can be fired outside the range of anti-aircraft fire and is more accurate than conventional bombs, according to Saab. It can be used against land or sea targets. Sweden has another guided missile, Type 315, which is a naval surface-to-surface missile for use from destroyer type vessels against other vessels. The 315 has two propulsion systems: for initial acceleration it has four built-in booster rockets; for cruising it employs a special type of jet engine. Guidance permits night missions.

Basic Research Support Urged

San Antonio—Strong national support for increased basic research efforts was urged by military and scientific experts at a conference sponsored by Southwest Research Institute.

Survival of the U.S. as a democracy over the next few decades was linked to the need for an accelerated program of pure scientific research by Col. Benjamin P. Blasingame, director, of the Titan intercontinental ballistic missile program. His views were supported by Dr. Alan T. Waterman, director of National Research Foundation, and Dr. Clifford C. Furnas, chancellor of the University of Buffalo and former Assistant Secretary of Defense for Research and Development.

Observing that science and defense are closely linked, Col. Blasingame said he is disturbed about the nation's position in the scientific world and the condition of the nation's security. He said it is a false hope to believe that science will so flourish in a free country like the U.S. that it automatically will assure scientific superiority.

Blasingame told the conference that the U.S. must take action to assure an adequate scientific backlog. He said the urgent need is for the type of research that has no immediate reward in sight, but which will result in new knowledge that can be applied in many ways.

This view was echoed by Waterman. Waterman said the quality of U.S. research is excellent and that our scientists and engineers compare favorably with those of other nations. But he also said that the U.S. will quickly lose this advantage unless greater support is provided for basic research and unless the U.S. concentrates on teaching and training more students with scientific talent.

Waterman said the National Science Foundation alone could support at least three times as much basic research as it now does, and that other government agencies report they could do more of such work if the money were available.

There also is an urgent need for attention to proper research facilities such as nuclear accelerators, nuclear reactors, electronic computers and other capital facilities, Waterman said.

While the scientific manpower situation has improved somewhat in recent years, Waterman pointed out that only about half the high school graduates capable of college work actually go to college. He said the U.S. should increase efforts to attract more students to college level work, especially those with scientific aptitudes.

Noting that Russian satellite developments did not surprise U.S. scientists, Waterman observed that the American public were taken by surprise and demanded to know why the Soviet program is ahead of the U.S. program.

"If the net effect is to shake us out of our complacency a bit and cause us to take a hard look at some of the fundamental issues, all well and good," Waterman said. "But it will serve no useful purpose to turn things upside down in a hasty and ill-considered effort to right the situation."

Furnas also cited the need for more fundamental research, observing that since the arrival of Sputnik, it has become popular to support the cause of basic research.

"We do need more such research because our reservoirs of new knowledge of the laws of nature are running low. Moreover, the competition may be outdoing us at the present time."

Dr. Furnas noted that, with few exceptions, industrial research laboratories do not do much basic research in the true sense of the word. He said that emphasis on the practical applications makes it difficult to get support for the basic work and observed that sponsors, both government and private, are usually overcautious about putting much money "on the long shots. They prefer to play the safer ponies. I believe our national program suffers from this timidity."

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Polaris on Submarine Called Sound Concept

New York—Polaris intermediate range ballistic missile, launched from nuclear-powered submarine while submerged, was called "the soundest concept for employment of ballistic missiles" because unpredictable launching point makes the sub "invulnerable" to surprise attack and countermeasures, according to Rear Adm. John E. Clark, director of Navy's Guided Missiles Division.

Another major advantage, according to Clark, is that Polaris missile launching sites are removed from populated areas. Any marked increase in enemy activity in trying to determine location of naval forces could provide advance warning of an attack, Clark said.

Navy's guided missile chief predicted that piloted aircraft will be required for air defense and ground support in enemy territory because of difficulty of missile guidance systems in distinguishing friend from foe. He also indicated that present surface-to-surface missiles are not as effective as manned aircraft against "hardened targets."

WHO'S WHERE

(Continued from page 23)

Changes

William F. Cords, director of sales, Pachmayr Corp., Los Angeles, Calif.

T. C. Wisenbaker, assistant division manager, Missile Systems Division, Raytheon Manufacturing Co., Waltham, Mass. **H. T. Ashworth** succeeds Mr. Wisenbaker as manager of Raytheon's Bristol, Tenn., plant.

Charles Proctor, chief production engineer, Topp Industries, Inc., Beverly Hills, Calif.

Samuel J. Childs, group executive, Defense Products Group, American Machine & Foundry Co., Alexandria, Va.

Jackson K. Lightfoot, chief engineer, Missile Products Division, Beckman & Whitley, Inc., San Carlos, Calif.

Emilio Ghiosso, production chief, Grumman Aircraft Engineering Corp., Bethpage, N. Y.

Alan W. Abels, manager-export sales, and **C. Gordon Wolcott,** manager-domestic sales, Convair 880 program, Convair, division of General Dynamics Corp., San Diego, Calif.

Dr. R. J. Creagan, nuclear program head, Bendix Aviation Corp., Detroit, Mich.

Brig. Gen. John M. Sterling (USAF, ret.), assistant to the vice president for European operations (Paris, France), Republic Aviation Corp., Farmingdale, N. Y.

William G. McLaughlin, chief of research, Hayes Aircraft Corp., Birmingham, Ala.

Frank H. Robbins, director-development and production engines, Aviation Gas Turbine Division, Westinghouse Electric Corp., Kansas City, Mo.

W. J. Borth, assistant to the vice president, Aluminum Taper Milling Division, Altamil Corp., El Segundo, Calif.

C. Douglas Flanigen, chief engineer, Lycoming Division, Avco Manufacturing Corp., Stratford, Conn.

John E. Holden, administrative engineer, Chandler-Evans, division of Pratt & Whitney Company, Inc., West Hartford, Conn.

Robert M. Flanagan, assistant chief engineer, Stratos Division, Fairchild Engine & Airplane Corp., Bay Shore, N. Y. **Gregory W. Knowles** succeeds Mr. Flanagan as chief project engineer.

Hugh I. Gillham, chief engineer, Trecker Aircraft Corp., Milwaukee, Wisc.

Thomas J. May, chief engineer, Commercial Division, Weber Aircraft Corp., Burbank, Calif.

Robert A. Earley, general superintendent-manufacturing (Bldg. 2), Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn. **Harold A. Rourke** replaces Mr. Earley as superintendent of experimental manufacture.

Everett Gravenhorst, director of engineering-Fluid Systems Division, Waldorf Instrument Co., Huntington Station, N. Y.

Heston H. Cherry, weapon system manager-WS 202A (YF-108) long-range interceptor project, North American Aviation, Inc., Los Angeles, Calif. **M. A. G. Robinson** replaces Mr. Cherry as project manager-XSM-64 (Navaho) project, Missile Development Division.

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MOCK electronic warfare, battle of wits between men armed with electronic countermeasures, is fought at installations such as one shown above and at right, operated by Radiation, Inc., in Florida for Air Force, and a larger site located near Rome Air Development Center.

Exclusive Report on Countermeasures: Part II

Avionic War Aims at Deceit, Confusion

By Philip J. Klass

New York—"Any radar or radio communications system can be jammed, given sufficient time and effort," one of the Air Force's top electronic countermeasures specialists declares.

This means any missile guided by electromagnetic radiation (radio, radar or infrared) is potentially vulnerable to enemy countermeasures and this includes a major portion of the U. S. missile inventory. Only ballistic missiles and others, like Snark, that are guided by inertial or celestial reference are largely immune. The latter can only be used against fixed targets with known positions.

The term "jamming" is sometimes applied loosely to all types of electronic countermeasures, including both active and passive types. Usually the term is applied only to active types of electronic countermeasures.

Battle of Wits

It is common practice to speak of jamming an enemy radar or radio as if electronic warfare were waged solely between two inanimate objects, i.e. the electronic countermeasure equipment and the radar/radio set. In reality, electronic warfare is a continuous battle of wits between people armed with electronic countermeasures and electronic counter-countermeasures, and between the scientists behind the lines who develop this equipment.

For example, if a B-52 crew finds its airplane under radar surveillance by an attacking interceptor it does not always turn on its electronic countermeasures equipment. To do so might pinpoint the bomber's location for the interceptor better than the latter's radar. The electronic countermeasures operator must analyze the tactical situation before deciding whether to jam or maintain electronic countermeasures silence.

Even when electronic countermeasures are used against a missile guided by electromagnetic radiation, the battle is one between humans: the electronic countermeasures operator and the men who operate or design the missile guidance system.

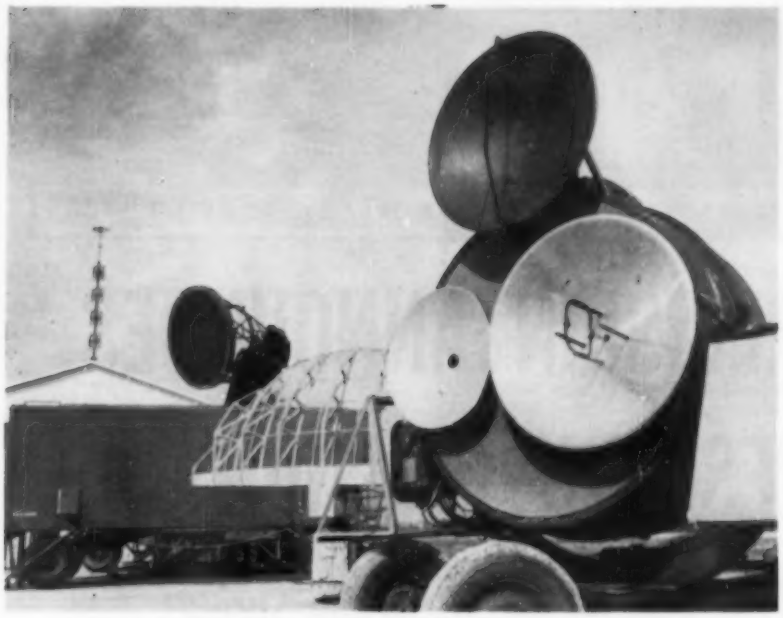
What is Jamming?

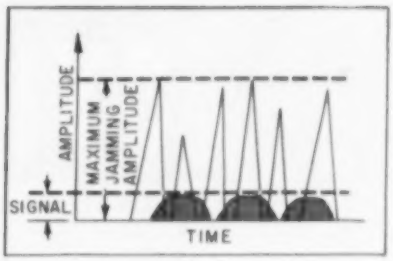
In the strict sense of the word, jamming is the most elementary form of active electronic countermeasures—the transmission of electromagnetic radiation, usually at the same frequency as that on which the radio or radar is operating. The electronic countermeasures transmission seeks to overpower the radio/radar signal or to irritate and confuse the operator. This brute force approach has the advantage of requiring only comparatively simple equipment. It has the significant disadvantage of disclosing to the enemy that he is being jammed.

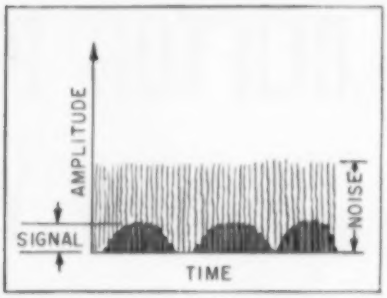
More advanced and sophisticated types of active electronic countermeasures seek to deceive and/or confuse the enemy without alerting him to the fact that electronic countermeasures are being employed against him.

Active electronic countermeasures originated with attempts to jam radio communications. These techniques were adapted and used later against radar when it appeared on the military horizon. Some of the jamming techniques used against radio communications include:

- **Spark jamming**—one of the simplest and earliest techniques, it employs a spark gap to produce short-duration jagged peaks of noise. The effect resembles the noise produced by some electric razors in home broadcast receivers. Spark jamming is relatively easy to produce at low frequencies.
- **White noise**—a more sophisticated version of spark jamming which can be employed at any frequency. The random noise produced by gas discharge tubes, for example, can be used to modulate the electronic countermeasures transmitter's output. Noise or spark jamming generally is considered a brute force technique because it requires considerable transmitter power, radiated over a sizable band width (portion of the spectrum) to be continuously effective.
- **Sweep-through jamming**—a moderately simple but effective form of counter-measures, is produced by sweeping the carrier frequency of the electronic countermeasures transmitter back and forth over a segment of the spectrum at a rate of several hundred cycles per second. This creates hundreds of noise pulses per second in the radio receiver, each momentarily blanking out the incoming message. Because of the time required by radio receiver detector cir-







JAMMING techniques include simple spark-produced interference employed at low frequencies (upper) and random (white) noise modulation usable at any frequency (lower).

cuits and the human ear to recover from each of these pulses, the effect is equivalent to continuous jamming. However, this technique has the advantage that available energy is concentrated in a relatively narrow band width, reducing transmitter power required. A single jammer of this type also can be employed against many different receivers operating at different frequencies.

• **Stepped-tone jamming** consists of a sequence of different audio tones repeated over and over. It sometimes is called "bagpipes" because it produces a sound like the wail of this instrument. Although the tonal sequence, continuously repeated, does not completely blot out the incoming signal, it can be extremely disturbing to a radio operator.

• **Heterodyne jamming** is based on the principle that an electronic countermeasures transmitter operating on a carrier frequency which differs slightly (3,000 cycles or less) from the radio transmitter frequency will produce a continuous beat note (tone) in the receiver's output. This is the familiar high-pitched squeal heard in home receivers when they are in need of adjustment. If the carrier frequency of the electronic countermeasures transmitter is slowly swept back and forth across the radio's frequency, the resulting beat note in the radio operator's ear resembles the proverbial wail of a banshee.

Continuous Look-Through

In addition to alerting the enemy to the fact that electronic countermeasures are being used against him, simple jamming has another disadvantage in that it prevents interception of the enemy's communications for our own intelligence purposes. Recently, however, the Air Force has developed "continuous look-through" techniques which make it possible to receive and transmit simultaneously on the same frequency. This opens the way to receiving an enemy transmission while simultaneously jamming the radio receivers at the other terminal.

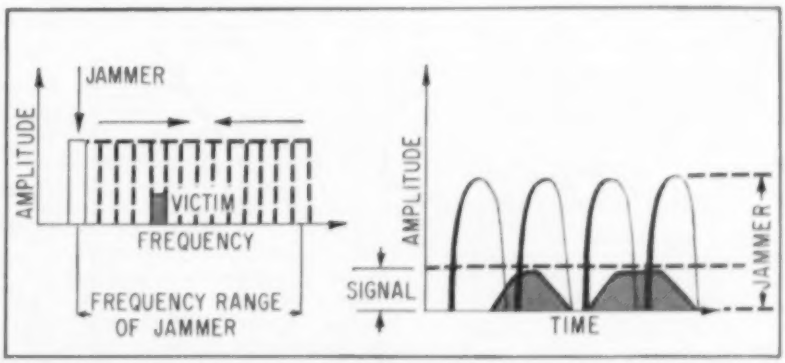
A more subtle form of electronic countermeasures can be employed to deceive and disrupt the enemy without his knowledge. This is the use of radio broadcasts, in the enemy's native tongue, intended to fool him into thinking they are coming from his own transmitters. Such deceptive countermeasures are far more difficult to bring off successfully, but offer greater tactical pay-off.

During World War II, for example, the British operated radio transmitters which were manned by German language operators. These operators would give false ground-control intercept instructions to German fighters seeking to locate attacking bombers. Not infrequently the German and British radio operators would give countermanding instructions and engage in heated arguments as to which was the authentic station, while German pilots milled around the sky completely befuddled.

Radar Jamming

Germans got their first exposure to U.S. radar jammers in October, 1943. In a mass raid on Bremen, Air Force bombers equipped with crude jammers (code-named "Carpet") suffered only half the losses of non-equipped aircraft against German radar-controlled anti-aircraft batteries. As jamming equipment and techniques improved, anti-aircraft losses dropped further.

Combined use of both chaff and jamming really made things tough for the Germans. To enable their radars



SWEEP through jamming, a more sophisticated technique, concentrates jamming power in narrow band but can be used against equipment operating at different frequencies.

SYNCHRO NEWS

CLIFTON HEIGHTS, PA. DECEMBER 1957 Vol. 1 No. 1

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Colorado Springs Area Named

Production Capacity Doubled

Clifton Heights, Pa., November 4, 1957—Clifton Precision Products Co., Inc. today announced completion of arrangements for the purchase of a 33,000 sq. ft. plant at Colorado Springs, Colorado. The plant will approximately double the Company's capacity to produce synchros and electro-mechanical components for aircraft and missile instrumentation, guidance and control.

The new plant, which is situated on 13 acres of land at the foot of the Rocky Mountains, is presently being equipped and will be in production shortly.

Clifton Precision is a leading independent manufacturer of synchros, servo motors and all types of rotary components for airborne electronic equipment. The Company has specialized in sub miniature, high accuracy units.

to distinguish moving bombers from slow-drifting chaff, the Germans developed and added moving target indication (MTI) circuitry. But this made the radars more vulnerable to Allied jammers.

In the Pacific Theater, B-29s were outfitted with jamming equipment following electronic countermeasures reconnaissance of Japanese ground radars. On daylight raids, when B-29s flew close formation, one jammer in a single B-29 could protect the entire group against a single ground radar. If there were several Japanese radars, each operating at different frequencies, jammers in several B-29s were used, one against each enemy radar.

But for the loose formations used in night missions, a single jammer could not protect the group. A few B-29s were therefore outfitted as electronic countermeasure aircraft, equipped with as many as 18 jammers, plus receivers and operators.

Nicknamed "porcupines" because of their many spinelike electronic countermeasures antennas, these aircraft flew high over the target area along a course parallel to the incoming B-29 bombers and jammed ground radars until the raid was completed.

Jamming Techniques

World War II jammers employed techniques adapted from radio jamming. Most widely used jamming signal was simply a white (random) noise modulation of the transmitted carrier. On early World War II A-scope-type radar presentations, which showed a target blip along a horizontal axis calibrated in range to target, the white noise obscured a target blip as tall grass hides a golf ball.

Because radar receivers are designed to operate from extremely low level signals reflected from the target, a modest-power jammer in the target is sufficient to swamp the radar echo. For example, original Carpet jammers had output of only 5 w., later raised to about 15 w. The subsequent AN/APQ-9 had an output of only 25 w.

Anti-electronic countermeasures techniques developed since the war, such as the use of integration, make it possible to detect target echoes more easily in the presence of random noise. This has forced electronic countermeasures designers to develop more sophisticated techniques, most of them tailored to the particular idiosyncrasies of radar.

A more subtle way to confuse a radar and its operator is to design electronic countermeasures to mimic the radar to be jammed. Radar has two basic mechanisms for determining target bearing and range. The direction in which the radar antenna is pointing when the echo is received establishes target bearing. Transit time required for a radar pulse to travel from the antenna to the target and back determines target distance.

ASSOCIATION of Old Crows is informal association of persons who are or were active in electronic countermeasures. Name is derived from "Raven," code name used for World War II countermeasures. For more information, write Old Crow Headquarters, CGS Laboratories, 391 Ludlow St., Stamford, Conn.

False Targets

One of the more obvious ways to fool a radar is to create a number of false targets, each at a slightly different range but at roughly the same bearing as the actual target. This can be accomplished by equipping the target with a small electronic countermeasure transmitter which sends out a series of pulses at suitably spaced intervals each time that a pulse arrives from the radar to be jammed.

If the electronic countermeasures pulses have the same length (time duration), repetition rate and carrier frequency as the radar to be jammed, they cannot be distinguished from echoes returned by actual targets (unless the radar employs suitable counter-electronic countermeasures techniques). The radar scope will therefore display a series of blips, only one of which is the actual target. Under certain conditions, the radar may display only the false target blips and the actual target position may not even appear on the scope.

Range Pull-Off

For radar-directed interceptors and radar-guided missiles, accurate information on target range and rate-of-change is needed to compute anticipated future position of the target at which the interceptor or missile should be aimed. If false range information is provided by the radar, as the result of electronic countermeasures action, the computer produces erroneous guidance instructions which will misguide the interceptor or missile.

When an interceptor/missile radar has locked onto its target, special tracking circuits within the radar are effectively clamped onto the echo returned from the target. They follow any change in target bearing or range. One sophisticated countermeasures approach intended to provide erroneous range data is called "range pull-off." Here the target's electronic countermeasures transmitter initially transmits a single pulse in synchronism with each pulse received from the radar so that the jammer effectively strengthens the weak echo returned from the target.

Then the target's electronic countermeasures transmitter slowly begins to shift the timing of its own pulse transmissions, corresponding to a change in target range. The radar tracking circuits unwittingly follow the signal received from the electronic countermeasures transmitter, ignoring the far weaker signal (echo) received from the target itself.

Creation of false target bearing information provides considerably more protection for a target than producing spurious target range signals. However, the former is a far more difficult task for electronic countermeasures.

If reconnaissance reveals that a surveillance radar to be jammed has significant side lobes because of poor antenna design, these small low-power beams on either side of the main beam can be used to produce false target bearing information. The target jammer remains silent when it is illuminated by the main beam, but sends out spurious pulses when illuminated by the side lobes. This creates spurious targets on the radar scope whose bearings are offset by a few degrees from true target bearing.

Decoy Missiles

Most obvious way to produce grossly misleading target bearing information on surveillance radar scopes or to mislead radar-guided interceptors and missiles is to use decoy missiles. Such a missile, carried under the wings of a bomber, for example, might be equipped with simple built-in radar reflectors which enhance the echo strength to make the decoy appear to be a bomber. Or the decoy can be outfitted with a small electronic countermeasures mimic transmitter.

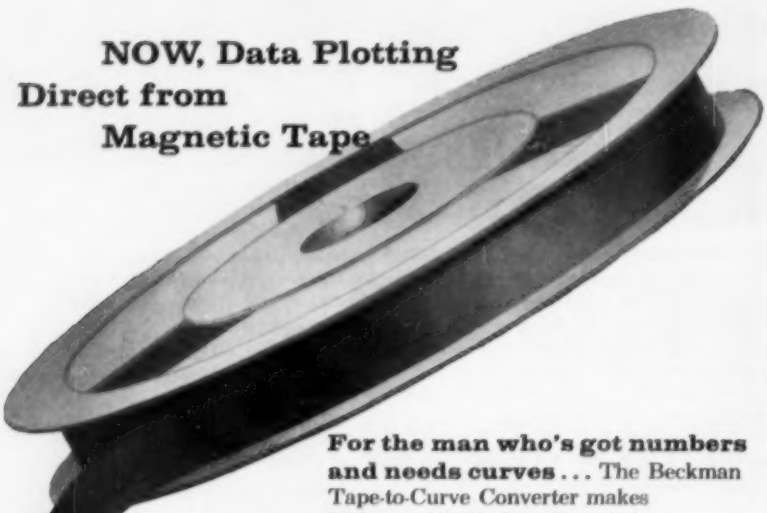
When a bomber's electronic countermeasures operator finds the aircraft being illuminated by radar energy, reconnaissance receivers are first used to analyze the radar's characteristics, i.e., frequency, pulse length, repetition rate, etc. The electronic countermeasures transmitter in the underwing missile then is set, by remote control, to mimic the radar to be jammed, and is turned on.

Because the missile's electronic countermeasures transmitter or reflector produces a stronger signal than the bomber itself, the radar will lock onto the decoy.

When the decoy missile is launched, the radar will follow it instead of the bomber.

Air Force currently has at least two

NOW, Data Plotting Direct from Magnetic Tape



For the man who's got numbers and needs curves . . . The Beckman Tape-to-Curve Converter makes high-speed X-Y plots *directly* from magnetic tapes containing raw digital data or computed output from electronic data computing machines. It makes up to 100 separate plots, 1000 points, in 30 minutes – nine plots per 30″x 30″ sheet.

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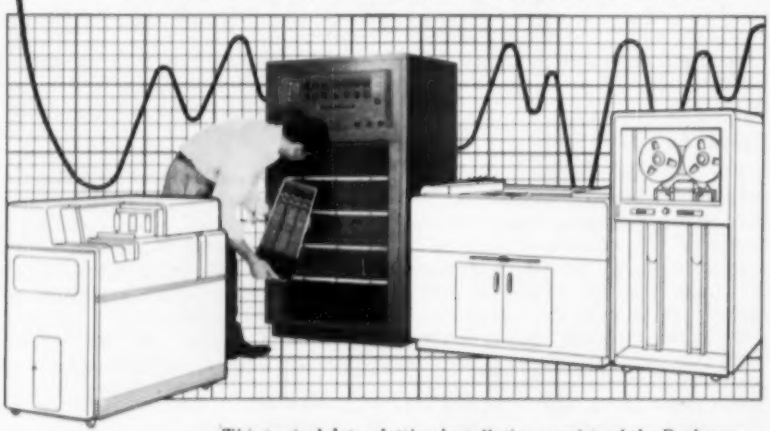
The Beckman Tape-to-Curve Converter is an invaluable supplement to users of IBM 700 series and IBM 650's equipped with magnetic tape. It is essential in any application where the rapid plotting of large quantities of data is important – from the evaluation of geophysical data to the graphical depiction of chemical processes, aircraft tests, or business statistics.

For more information on the Beckman Tape-to-Curve Converter or other modern data handling systems, write for Data File D-14-7.



This typical data plotting installation consists of the Beckman Tape-to-Curve Converter, IBM Reproducing Punch, IBM Magnetic Tape Unit, and an Electronic Associates Variplotter.

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electronic countermeasures decoy missiles under development. One, called the Quail, is being developed by McDonnell Aircraft Co. The other, called the Goose, is being produced by Fairchild Aircraft.

Another type decoy missile, for deployment against infrared-guided missiles like the Sidewinder, could be equipped with high intensity flares intended to lure the missile away from the aircraft's jet engine tail pipes. Jamming of infrared systems, in the strict sense of the word, is impossible because they do not radiate electromagnetic energy but merely sense radiation emitted by the target.

Combined Techniques

In operational use, reconnaissance, passive and active electronic countermeasures equipments are usually employed in combination. For example, ferret aircraft used to reconnoiter enemy radar/radio facilities may find it desirable to employ jamming in order to determine whether the enemy has secret radio/radar facilities which it is holding in reserve.

Employment of both active and passive countermeasures often makes it more difficult to develop counter-electronic countermeasures techniques—as demonstrated by Germany's experience in World War II.

Number and variety of electronic countermeasures equipment carried aboard modern bombers has had such a Topsy-like growth in recent years that the military has been forced to adopt a weapon systems approach. For example, Sylvania is developing a complete electronic countermeasures pod which can be carried by the B-58 in lieu of a bomb load to provide an electronic countermeasures umbrella for bomb-carrying B-58s. Sperry Rand recently received an $80 million contract to develop a similar pod for the B-52.

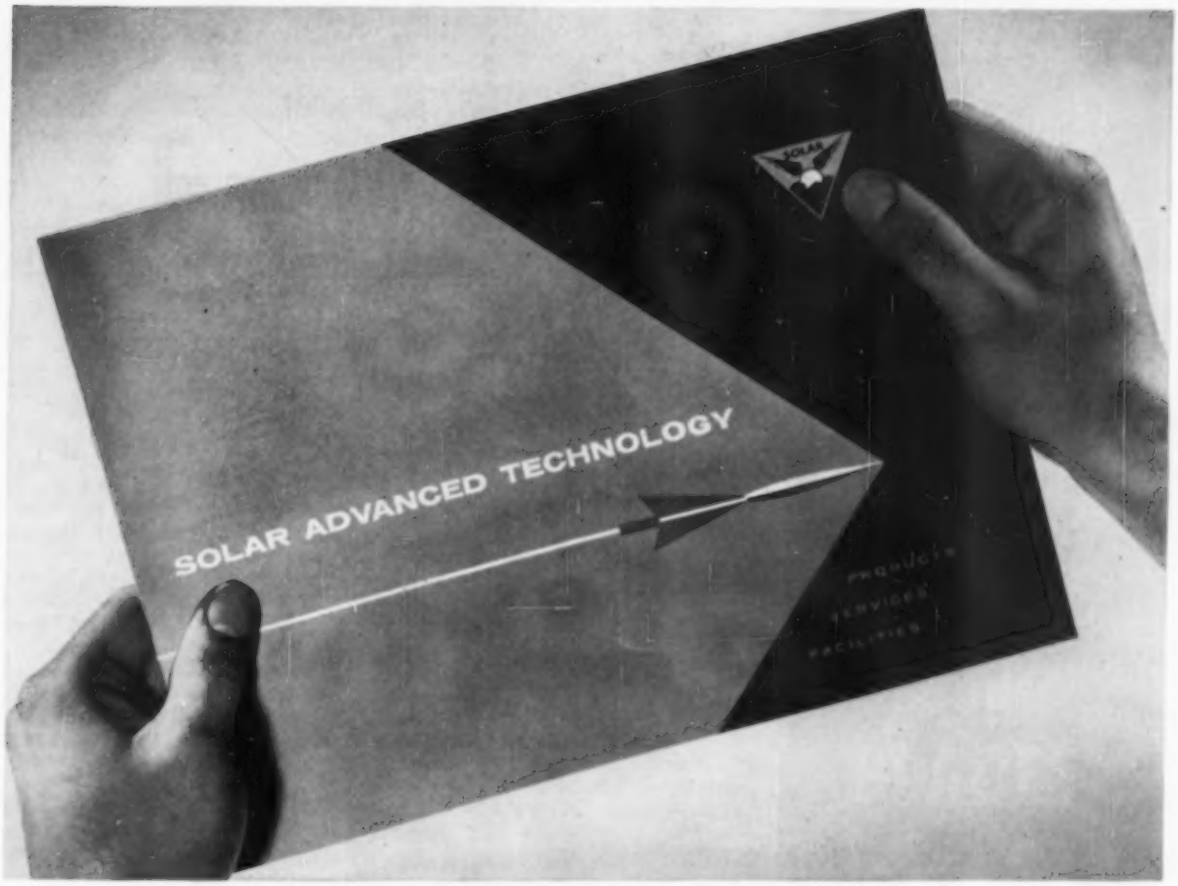
Smaller integrated electronic countermeasures pods are being developed for use by fighter aircraft.

Counter-Countermeasures

Growing effort in electronic countermeasures, resulting from the fast-increasing military dependence upon electromagnetic radiation for detection, weapon guidance and communications, has in turn spawned a growing effort in electronic counter-countermeasures. Rome Air Development Center recently held a major industry symposium on the subject.

Electronic counter-countermeasures, like electronic countermeasures, is primarily a battle of wits between men—those who design and those who operate radar/radio systems and countermeasures equipment.

A few examples will illustrate the nature of electronic counter-counter-



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measures. Many of the passive and active electronic countermeasures devices described must be tuned to the operating frequency of the radar/radio they seek to counter if they are to be effective. The obvious way to counter such frequency sensitive devices is to design radio/radar systems so they can change their operating frequency quickly.

DEW Line radars, for example, incorporate this provision.

To meet this challenge, electronic countermeasures designers try to develop equipment which is effective over a broad frequency range, or which can switch frequency rapidly. However, any time lag between a change of radar frequency and the resultant shift in electronic countermeasures frequency can alert the radar operator to the jammer's presence.

Against jammers which seek to mimic a radar, other electronic counter-countermeasures techniques can be employed. For example, the radar may switch to a different pulse length or repetition rate, or employ a continuously changing pulse repetition rate. There are other, more sophisticated techniques which can be used to give a radar pulse its own special identification, making it more difficult for electronic countermeasures to mimic the radar 100% of the time.

Quick Reactions

Successful electronic countermeasures and electronic counter-countermeasures depend heavily upon good reconnaissance of enemy electronic facilities and quick reaction capability in developing equipment to deny the enemy effective use of his facilities.

Quick reaction capability is particularly important in time of war. During World War II, the British were sometimes able to develop new electronic countermeasures equipment and put it into operational use within two weeks after a new German radio or radar put in its appearance.

Rome Air Development Center, which is responsible for sponsoring development of all Air Force ground-based electronic countermeasures, maintains an in-house capability for speedy development of electronic countermeasures equipment and sponsors a similiar capability with at least one avionics manufacturer.

Rome Air Development Center also operates two electronic countermeasures test sites near Rome for evaluating effectiveness of ground-based and airborne electronic countermeasures. Ranges are equipped with almost every type of radar and communications equipment in the past and present military inventory to test their electronic countermeasures vulnerability. Radiation, Inc., Melbourne, Fla., also operates a small electronic countermeasures range under Rome contract, using radars modified to operate at frequencies known to be used by the Russians.

Never-Ending Race

Designing electronic countermeasures and electronic counter-countermeasures is a never-ending race. When electronic countermeasures designers come up with new techniques to jam or confuse existing U. S. radars, radar designers are pressed to develop techniques for countering the new technique.

In one sense the airborne countermeasures designer has an easier task than those designing ground-based electronic countermeasures because peacetime reconnaissance provides the former with considerable information about the enemy ground-based radar/radio he must counter. The ground-based electronic countermeasures designer must work with far less information on the type of airborne radar/radio that may be used against him.

On the other hand, designers of airborne countermeasures equipment are restricted by the familiar limitations on size, weight, power consumption and complexity. The ground-based radar/radio designer can employ considerably more sophistication in his anti-jamming circuitry and can use the brute strength approach of tremendous power.

Neither designer has a bed of roses. Development of sophisticated countermeasures equipment requires a detailed understanding of the operation of the equipment to be jammed in order to probe for and take advantage of weaknesses inherent in the equipment design.

A brief four years ago, relatively little money was available for electronic countermeasures development and there were comparatively few companies in the business. Today electronic countermeasures is comparatively big business, with military procurement estimated at about $400 million annually and with at least 30 companies active in the field.

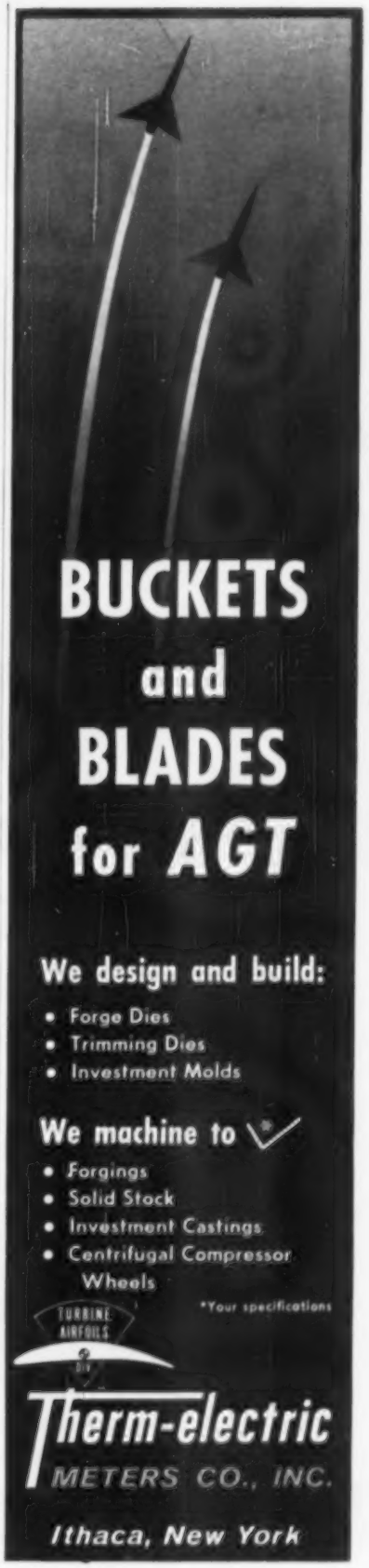
The current emphasis on missiles, many of them guided by electromagnetic radiation, suggests there will be growing emphasis on countermeasures.

Reprints Available

Reprints of Aviation Week's special report on electronic countermeasures will be available in approximately six weeks, at the following rates:

1-10 copies: 40 cents each.
11-100 copies: 30 cents each.
Over 100 copies: 20 cents each.

Orders should be addressed to: Aviation Week, Reprint Section, 330 West 42nd St., New York 36, N. Y.



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Neither does pressure. This hose has delivered 125 lbs. per minute of 425 F. air for 200 hours at 65 psi pressure. The schedule called for three hours on operation and one hour off.

This light and flexible hose comprises two silicone rubber layers covered by a synthetic fiber jacket. An extra outer jacket of corrugated rubber protects it against wear and abrasion. Lengths are continuous up to 50'. Couplings can be regular expansion and shank hose.

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English Electric Co. Aims for Reliability

London—One and a half million dollar research and development facility claimed to be the largest in Europe to concentrate on aircraft electrical equipment has been opened by the English Electric Co., Ltd.

The company is to concentrate on a.c. equipment. One of the main objects of the development program is to improve the performance and reliability of electrical equipment in high speed aircraft. The main problems are those arising at high altitudes from low humidity, high ambient temperatures and the reduced dielectric properties of air at low pressures.

One of the most urgent problems is brush wear. The company is concentrating on a brushless alternator utilizing rotating rectifiers, and has made good progress. Development of a "static" control gear is another major item in the company's effort to eliminate the worst sources of unreliability. But a great portion of the company's effort is directed at improvement of details and the application of a whole new family of organic and other non-metallic insulation, lubrication and molding materials. "Silicones are not the answer to everything," said Chief Engineer E. Rivett to AVIATION WEEK. "In fact, they have not lived up to expectations." Laminates developed for tape and sheeting requirements up to 200C favor the use of either synthetic mica or asbestos with glass cloth. Terylene is used extensively at the lower temperature range.

Among the latest molding materials are the epoxy resins filled with quartz filler.

Recent potted component developments include a.c. motors of only 1-in. diameter incorporating chemically etched laminations, interpole windings for 300 amp. generators and transducers.

English Electric is the only company offering a constant frequency generating system for multi-engined aircraft in which alternators are connected in parallel, and are wired and governed to share the load automatically. The company makes the Sundstrand Hydromechanical constant speed drive under license for this purpose. The first aircraft to be fitted with the system in Brtiain was the Vulcan and it is now scheduled for all the V-bombers. The weight saving in the Vulcan over its original d.c. equipment amounts to around 400 lb. and a reduction in the cooling drag penalty imposed on the machine by d.c. equipment means another 700 lb. for the payload.

The equipment is largely conventional and includes batteries of dynamo-

meters able to simulate complete aircraft electrical systems under load, high altitude chambers simulating conditions at 90,000 ft. and capable of accommodating complete electrical systems under load, search and endurance vibration testing equipment, a G-wheel and an explosion chamber and actuator test rigs.

Expansions, Changes In Avionics Industry

Electronic Specialty Co., Los Angeles, has purchased the Cado Division of Electromation, Inc., which will become part of the former's Radiating Systems Division. New acquisition produces subminiature coaxial switches and lobing switches, expanding Electronic Specialty's own line of RF components.

Other recently announced changes, expansions in the avionics industry include:

• **Ultradyne, Inc.**, Albuquerque, N. M., has purchased products and physical assets of Quantum Electronics, Inc., also of Albuquerque. New acquisition, which becomes a division of Ultradyne, manufactures power supplies, transistor analyzers. T. E. Lommasson, president and treasurer of Quantum Electronics, will continue to head its operations.

• **General Mills** has formed a Nuclear Equipment Department as part of company's Mechanical Division, to develop and produce remote control handling equipment for use in nuclear laboratories and reactors.

• **Jefferson Electric Co.**, Chicago, maker of transformers, will purchase Electronic Products Corp., Santa Barbara, Calif., which produces custom electric cables and avionic assemblies, providing stockholders approve. Purchase price is approximately $650,000. Entire management staff of Electronic Products Corp. will be retained.

FILTER CENTER

▶ **Quadruple Diversity Scatter**—Long-range single sideband tropospheric scatter system which General Electric is building for Air Force use in the Arctic will employ "quadruple diversity" to minimize fading. Two huge antennas, 150 ft. high by 120 ft. wide, will be employed at each terminus and each will be fed both horizontally and vertically polarized signals simultaneously. New system, expected to have a single-hop range of 700 miles, was developed by Lincoln Laboratory. Working mock-up of the system, suitable for simplex operation, will undergo test early next year between Boston and Winston-Salem, N. C.

▶ **New USAF Communications Center**—First of five new high-speed teletype centers, capable of handling three times as many messages with less than half the personnel formerly required, has gone into service at Andrews AFB near Washington, D. C. System was designed, installed and leased to Air Force by Western Union. Other four centers, located at Wright-Patterson AFB at Dayton, Robins AFB at Macon, Ga., McClellan AFB at Sacramento, Calif and Carswell AFB at Ft. Worth are slated to be completed by end of next year. The new high-speed system will then link more than 200 USAF terminal communication points throughout the nation.

▶ **For the Record**—Automatic 35 mm. cameras that photograph traffic control radar scope with every new sweep of the antenna, simultaneously photographing a clock to show exact time of each shot, are being installed experimentally on Civil Aeronautics Administration radars in New York, Chicago, Washington and Norfolk for assistance in evaluating air traffic control radar beacon system. The cameras are produced by Gordon Enterprises, North Hollywood, Calif.

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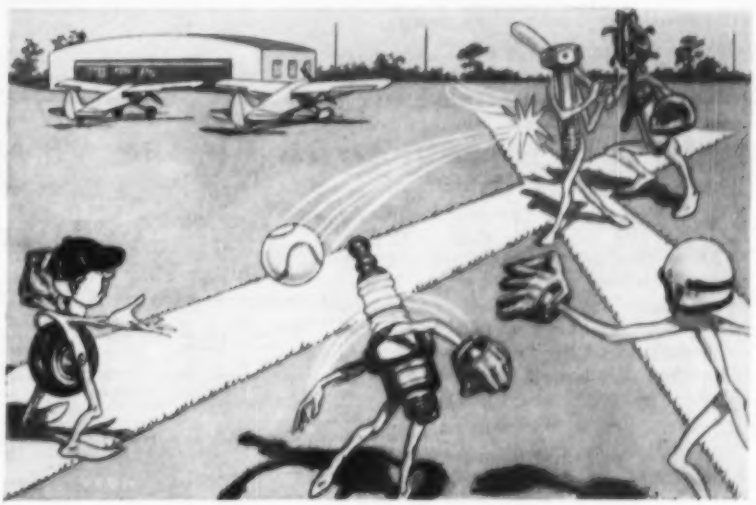

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Airborne standard miniaturized capacitors are rated 200 v d-c and have an operating temperature range of —75°F to +300°F with only 12% capacitance change. At 300°F they withstand 150% rated voltage for 250 hrs. through a resistance of 1 ohm per volt.

Where standard designs are not suitable, Airborne can produce special capacitors to meet your requirements. These custom miniatures likewise offer the advantage of reduced size and weight without sacrificing capacitance or dielectric strength. Typical is one of our new starting capacitors which is 75% lighter yet has twice the capacity and three times the dielectric strength of the old-style capacitor it replaced.

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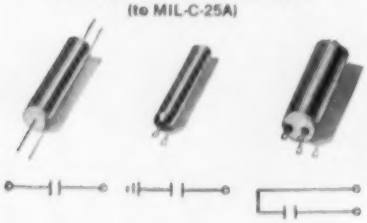
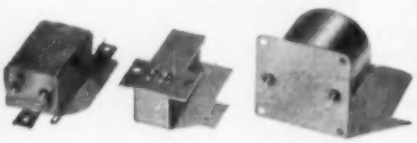
(to MIL-C-25A)



Style "A" Style "B" Style "C"

TYPICAL SPECIAL CAPACITORS
(to JAN-C-25, MIL-1-6181B, MIL-M-8609)



E-8109 Style E-8104 Style E-8107 Style

Airborne Standard Miniaturized Capacitors—200 v d-c

Microf. ±10%	Dia.	Length
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.5	1/2	1-1/4
1.0	5/8	1-1/4
3.0	7/8	1-1/8
4.0	1	1-1/8
5.0	1-5/32	1-1/8
6.0	1-1/4	1-1/8
7.0	1-5/16	1-1/8
8.0	1-29/64	1-1/8
9.0	1-1/2	1-1/8
.25	3/8	3/4
.4	1/2	3/4
.75	5/8	3/4
1.5	1	3/4
18.0	1-3/4	2-1/4

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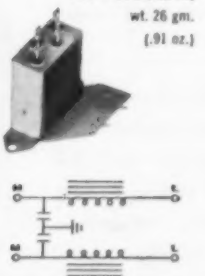
Airborne miniaturized r.f. filters also utilize Mylar dielectric and a special conducting material to reduce size and weight without compromising performance. Cores are molded to achieve maximum inductance with minimum bulk. Vacuum impregnated with polyamide resin; hermetically sealed in steel cans with glass terminals, Airborne miniaturized r.f. filters are serviceable from —75°F to +300°F. They meet JAN-C-25, MIL-1-6181B, and MIL-M-8609 and are available to your specifications. Typical standard constructions and circuits are shown at right, along with pertinent data on the motors to which these filters were matched. Mounting brackets are furnished to meet your requirements.

TYPICAL R.F. FILTERS

.94 x .50 x .81 in., wt. 15 gm.

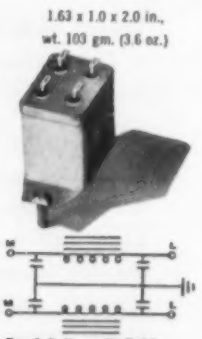
For 1.125 dia. split field series motor
No load current—.45 amp
Stall current—2.0 amp 100 v d-c
Comm-bar frequency—14 x 27000 rpm
Electro-graphitic brush

1.06 x .50 x 1.38 in., wt. 26 gm. (.91 oz.)



For 1.562 dia. split field series motor
No load current—2.8 amp
Stall current—18.5 amp
Comm-bar frequency—14 x 32000 rpm
Electro-graphitic brush

1.63 x 1.0 x 2.0 in., wt. 103 gm. (3.6 oz.)



For 2.2 dia. split field series motor
No load current—3.7 amp
Stall current—45 amp
Comm-bar frequency—14 x 18000 rpm
Electro-graphitic brush

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AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Alan Gordon, doing business as Gordon Enterprises, North Hollywood, Calif., $28,647 for clock assembly (spare part item) for type 0-15 camera system, 600 ea., erector head assembly (spare part item) for type N-9 gun camera system, 38 ea.

Fairchild Camera and Instrument Corp., Syosset, L. I., N. Y., $605,076 for aircraft still picture reconnaissance camera body, type D-3A for use with the aerial camera in support of the type RF-101 aircraft.

Motorola Inc., Chicago, $460,915 for generator-pulse, type AN/AWA-2 (installation), 229 ea., generator-pulse, type AN/AWA-2 (spares), 274 ea., coupler—directional, type CU-401, 600 ea.

International Business Machines Corp., Military Products Division, New York City, $420,000 for repair and/or modification of MA-2 bombing navigation systems used in service test program.

A/C Spark Plug Division, General Motors Corp., Flint, Mich., $470,261 for systems responsibility for the MA-6 & MA-7 bombing navigational systems, design responsibility for the MA-5 bombing navigational computer, field engineering service.

Bill Jack Scientific Instrument Co., Selana Beach, Calif., $86,765 for C-3 intervalometers, component of universal and simplified camera, control systems for use in RF-101 aircraft.

Hycon Manufacturing Co., Pasadena, Calif., $193,940 for LA-15 computer, LA-18 mounting base, for use with the universal and simplified camera control systems in reconnaissance aircraft RF-101.

Allen B. duMont Laboratories Inc., East Paterson, N. J., $168,685 for E-1 amplifier, B-4 mounting base, LA-21 control, request for proposal #4205 for use in RF-101 aircraft.

Chicago Aerial Industries Inc., Melrose Park, Ill., $85,500 for LA-19 image velocity detector, 74-0775 and LA-20 image converter, 74-0774 for use in RF-101 aircraft.

Westinghouse Electric Corp., Dayton, Ohio, $36,759 for panel and transformer regulator generator for B-52 test.

Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., $1,586,111 for main wheel assembly for B-52D, main brake assembly for B-52D.

Radio Corp. of America, Defense Electronics Products Division, Camden, N. J., $402,319 for automatic lead computing sight for MG-10/F-102A aircraft, electrically controlled amplifier for MG-10/F-102A aircraft and electrical equipment rack for MG-10/F-102A aircraft.

Hoover Electronics Co., Baltimore, $205,615 for AN/ARA-43(XA) interference blanker, Hoover model 10018 interference blanker, manufacturers representatives (60 man months).

Allison Division, General Motors Corp., Indianapolis, $330,000 for T56-A-7 turboprop engines for service test.

General Precision Laboratory, Pleasantville, N. Y., $1,678,460 for components of radar set AN/APN-81 for B-52 and KC-135 aircraft.

Sperry Gyroscope Division, Sperry Rand Corp., Great Neck, L. I., N. Y., $107,000 for type B-2A drum and bracket two-channel amplifier, type MA-1 switch assembly for use in C-124C and SC-124D aircraft.

Minneapolis-Honeywell Regulator Co., Aeronautical Division, Minneapolis, $117,780 for low altitude bombing systems computer set, type AN/AJB-5 for use in F-100F aircraft.

Systems Development Corp., Dayton, Ohio, $4,385,446 for product improvement of universal and simplified camera control system currently used in RB-47 and RF-101 aircraft.

Solar Aircraft Co., San Diego, $4,448,025 for gas turbine generator sets, type MA-1 burner assembly for KC-97 series aircraft.

Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., $1,171,859 for main wheel assembly for KC-135A aircraft, main brake assembly for KC-135 aircraft.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., $1,532,639 for components of compass system, spare parts and ground support equipment.

Lockheed Aircraft Service-Overseas Inc., Ontario, Calif., $1,721,251 for T-33A aircraft parts.

Radio Corp. of America, Camden, N. J., $5,282,598 for AN/ARC-21 radio sets.

Hughes Aircraft Co., Culver City, Calif., $1,181,560 for MG-10 aircraft and weapon control components.

General Precision Laboratory Inc., Pleasantville, N. Y., $1,678,560 for components of radar sets, spare parts and ground support equipment.

J. W. Bateson Co. Inc., Dallas, Texas, $2,408,540 for construction of base exchange of Air Force Academy at Colorado Springs, Colo.

Utica-Bend Corp. Utica, Mich., $5,892,000 for overhaul of J47 aircraft engines.

Bendix Aviation Corp., South Bend, Ind., two contracts totaling $2,757,970. The first is for $1,171,859 for wheel and brake assembly for KC-135A aircraft; the second, for $1,586,111, is for wheel and brake assemblies for B-52 aircraft.

Aero-Test Equipment Co. Inc., Dallas, $1,369,650 for construction and installation of altitude and compression test chambers.

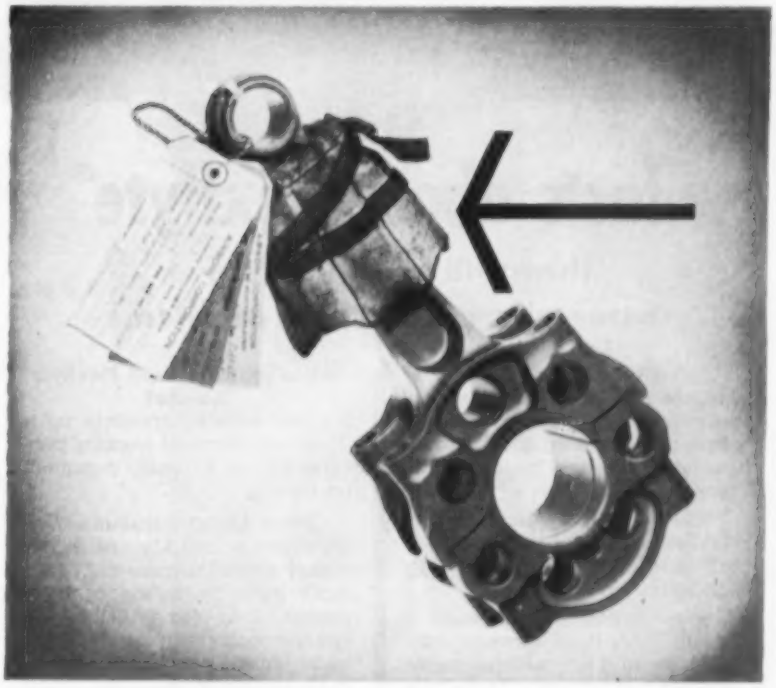
Hazeltine Corp., Electronic Division, Little Neck, L. I., N. Y., $1,209,305 for aircraft identification systems.

Solar Aircraft Co., San Diego, Calif., $4,448,025 for gas turbine generator sets for type MA-1 major assemblies.

AVCO Manufacturing Corp., Cincinnati, $1,747,835 for radar sets AN/MPS-16.

Puget Sound and Brake Joint Brake Ventruers, c/o Puget Sound Bridge & Dredging Co., Seattle, letter contract for $800,000 with estimated dollar amount of definitive contract for $4,225,000 for maintenance and operation of Point Barrow Camp, Point Barrow, Alaska.

Federal Electric Corp., Paramus, N. J.,



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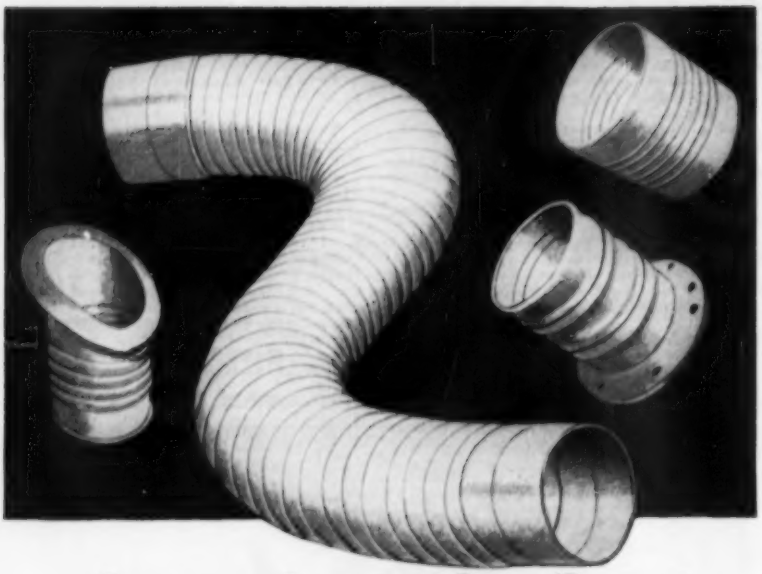

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It is highly resistant to abrasion, especially when coated with FT-506 which has more than 200 times the abrasion resistance of any tubing of its type and weight.

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Flexflyte has exceptionally high flame resistance and will not support combustion.

What pressures will Flexflyte handle?
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What about installation?
Flexflyte is quickly, easily installed around corners and equipment parts by means of metal clamps. It is also available with special enlarging or reducing ends, either cylindrical, rectangular or polyhedral.

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Yes, in many special shapes, fabrics, coatings, connections, lengths and diameters. Our special Silicone Department, working with automated machinery, is prepared to meet any requirement for silicone ducting.

How can I make sure that Flexflyte will solve my problems?
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letter contract for $2,630,000 with estimated definitive contract for $15,922,365 for operation and maintenance of the White Alice communications systems in Alaska.

Northrop Aircraft Inc., Hawthorne, Calif., $20,892,688 for definitization of engineering change proposals and modification of F-89D A/C to F-89J.

Land-Air Inc., Chicago, $97,500 for installation of ARC-27, ARN-14 and F-488 electronic power modification in C-47 and C-117 aircraft, and ARN-6 in C-47 and C-117 aircraft.

Land-Air Inc., Chicago, $189,000 to accomplish technical order no. 1C-124-596, propeller modification on C-124 aircraft.

Westinghouse Electric Corp., Dayton, $29,600 for contract, technical services in connection with B-52 alternators.

Pacific Airmotive Corp., Burbank, Calif., $27,376 for overhaul of type O-335 aircraft engines.

University of Denver, Denver, Colo., $50,000 for operations analysis, standby project.

McGregor & Werner Midwest Corp., Dayton, Ohio, $57,743 for marginally punched forms for use on I.B.M. model 407 machines.

University of Pennsylvania, Philadelphia, $58,000 for operations analysis, standby project.

Oakland Aircraft Engine Service Inc., Oakland, Calif., $91,444 for overhaul and conversion of R-985-1/3/39 type aircraft engines to R-985-14B type.

Hayes Aircraft Corp., Birmingham, Ala., $300,000 for IRAN maintenance and modification of B-50 aircraft.

Philco Corp., Philadelphia, Pa., $201,253 for on-site technical operation and maintenance of AAC, AC&W radar and other C&E equipment.

CAA Contracts

Washington—Following is a list of contracts as released by the Civil Aeronautics Administration:

Topp Manufacturing Co. Communications Division, Los Angeles, $1,099,729.95 for 65 VHF omnidirectional radio ranges (VOR) and related equipment.

Wagner and Swasey Co., Lansing, Mich., $876,934.36 for 163 engine generators.

Consolidated Diesel Electric Corp., Stamford, Conn., $322,853.96 for 74 engine generators.

Raytheon Manufacturing Co., Waltham, Mass., $260,920.48 for 88 remote video mixing/gating systems and related equipment.

Topp Manufacturing Co., Communications Division, Los Angeles, $190,186.26 for 54 VHF localiser transmitters and related equipment.

Teletype Corp., Chicago, $162,106.95 for modification kits and related equipment for distortion transmitter distributors.

Wilcox Electric Co., Kansas City, Mo., $146,659.65 for 14 transmitter assemblies and related equipment.

Lawn Electronics Co. Inc., Freehold, N. J., $135,559.74 for transmitter control panels.

Curtiss-Wright Corp., Electronics Division, Carlstadt, N. J., $132,478.05 for 15 radar target simulators.

Lincoln Electric Products Co. Inc., East Orange, N. J., $67,416 for 593 panelboards.

ITE Circuit Breaker Co., Philadelphia, $56,500 for 10 circular polarization kits for airport surveillance radar.

Cummins Engine Inc., Columbus, Ind., $54,724.44 for six engine generators.

Waukesha Motor Co., Waukesha, Wisc., $41,107 for three engine generators.

Teletype Corp., Chicago, $40,384.41 for 33 receive-only printers and spare parts.

D. S. Kennedy & Co., Cohasset, Mass., $17,660 for antenna reflectors and supports.

Perkins Engineering Corp., El Segundo, Calif., $5,310 for regulated power supply units.

The Esterline-Angus Co. Inc., Indianapolis, $2,877.50 for graphic milliameters.

Magnetic Research Corp., Hawthorne, Calif., $1,920 for regulated power supply units.

Sylvania Electric Products Inc., Philadelphia, $1,726 for two panelboards.

Maryland Electronic Manufacturing Corp., College Park, Md., $168,672.49 for ILS

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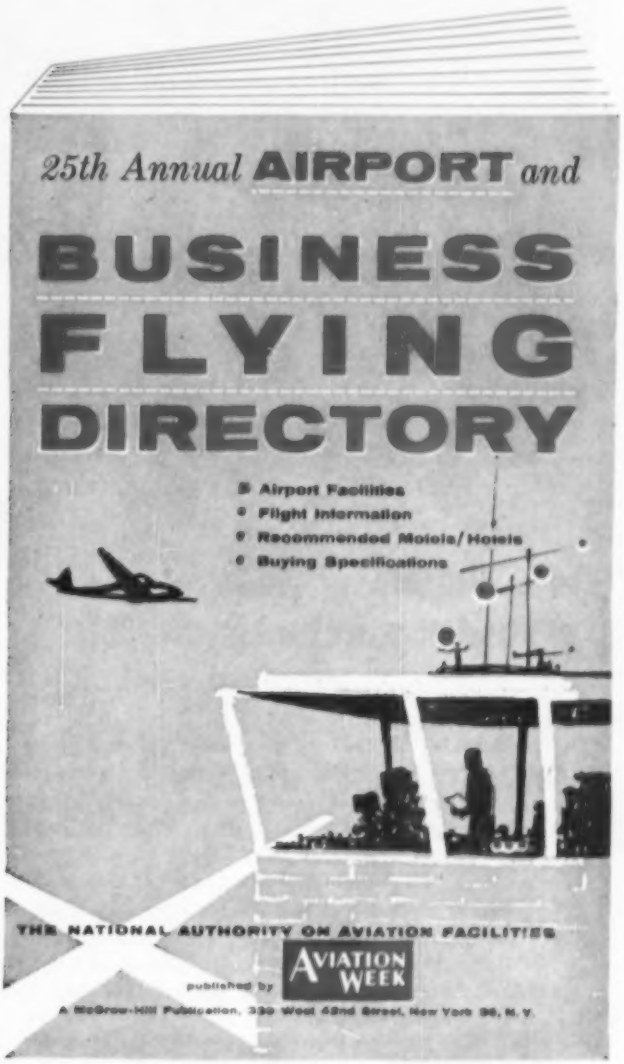

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AW1

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J-M Tadpole Firewall Seals *block passage of flame and combustibles between compartments*

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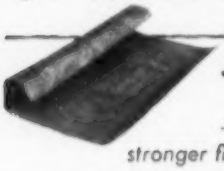
J-M Tadpole Seals are made with a specially processed Inconel wire mesh core. This base is covered with asbestos cloth combined with Neoprene, Silicone, Teflon or other materials to assure top performance within each temperature range. All seals comply with the C.A.A. requirements for flame resistance. Style numbers and temperature limits are as follows: 4132-250 F, 137-350 F, 4134-450 F, 4133-500 F, 4161-600 F, 4381-over 600 F.



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#89 Bomber Cloth flexible firewall fabric saves precious pounds. It is the lightest material of its type, yet withstands the most severe C.A.A. tests.

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localizer monitors and related equipment.

Gertsch Products Inc., Los Angeles, $148,708.96 for frequency meters.

Benrus Watch Co., Waterbury, Conn., $98,780.68 for fixed tune VHF receivers and spare parts.

Hewlett-Packard Co., Palo Alto, Calif., $62,747.68 for wave analyzers and oscillators.

Audicon Electronics, Inc., Paterson, N. J., $62,674.03 for dual channel amplifiers and spare parts.

Columbus Electronics Corp., Yonkers, N. Y., $58,710.26 for regulated output amplifiers and spare parts.

Bendix Aviation Corp., Bendix Radio Division, Baltimore, $28,759.02 for marker beacon receivers, weather radar receivers and transmitters and associated equipment.

Sperry Gyroscope Co., Great Neck, L. I., N. Y., $12,419 for Gyroson compass indicators.

Maryland Electronic Manufacturing Corp., College Park, Md., $10,462.90 for ILS glide scope monitors and spare parts.

USAF Contracts

Washington—Following is a list of unclassified contracts for $25,000 and over as released by Air Force Contracting Offices:

DAYTON AFD, Gentile AFS, Dayton 10, Ohio.

Pitometer Log Corp., New York City, AN/UPM-72 radar test set, in a/w Mil. Spec. MIL-T-9532 (USAF) and changes under exhibit A, the following components shall be supplied in quantities as indicated: indicator unit, 450 ea.; tuning unit, option I, 190 ea.; tuning unit, option II, 280 ea.; RFP 33-604-57-3112, $775,000.

General Electric Co., Utica, N. Y., transmitter group OA-1463/ALT-6B consisting of, oscillators, O-498/ALT-6B, 100 ea., control indicators, C-2162, 100 ea., PR: MD-8-16K1-25008 & Amendment number 1, $677,-600.

MIDDLETOWN AMA, Olmstead AFB, Pa.

Decker Aviation Corp., Philadelphia, repair of I-4 compass components, RFP 36-600-58-5004, PR: MA-8-05A-16, $46,291.

CAMBRIDGE RESEARCH CENTER, ARDC, Bedford, Mass.

W. H. Hughes Inc., Watertown, Mass., repair lighting on runway 11-29 (Project CA-88-7, less rock excavations AF19(604)-3134), $27,129.

OGDEN AMA, Hill AFB, Utah.

Aero-Test Equipment Co., Dallas, altitude test chambers (IFB 42-600-57-292), $1,-369,650.

WARNER ROBINS AMA, Robins AFB, Ga.

Hughes Aircraft Co., Los Angeles, repair and/or modification of E, MG and MA series FCS and/or AWCS systems, $4,194,-320.

Pry Welding and Manufacturing, Warner Robins, Ga., repair and/or modification of R-4360 aircraft engine containers (RFP No. MPC-58-I, local purchase), $263,492.

Crosley Division, AVCO Manufacturing Corp., Cincinnati, spare parts applicable to A5, MD-4 and MD-5 FCS (RFP 58-1019), $28,880.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., spare parts applicable to A1 and ME-4 computers (RFP-57-1265), $71,572.

The National Cash Register Co., Dayton, Ohio, spare parts applicable to various navigational computers (REP-57-1265), $187,293.

MEMPHIS AFD, Mallory AFS, Memphis, Tenn.

Precision Tool Co. Inc., services—class 51A engines (AF-40(604)-7100), $25,535.

TOPEKA AFD, Topeka AFS, Topeka, Kan.

Aluminum Co. of America, Washington, aluminum tubing, alloy (IFB 14-604-57-1150), 11,600 lbs., $42,278.

ENGINEER OPPORTUNITIES AT RAYTHEON

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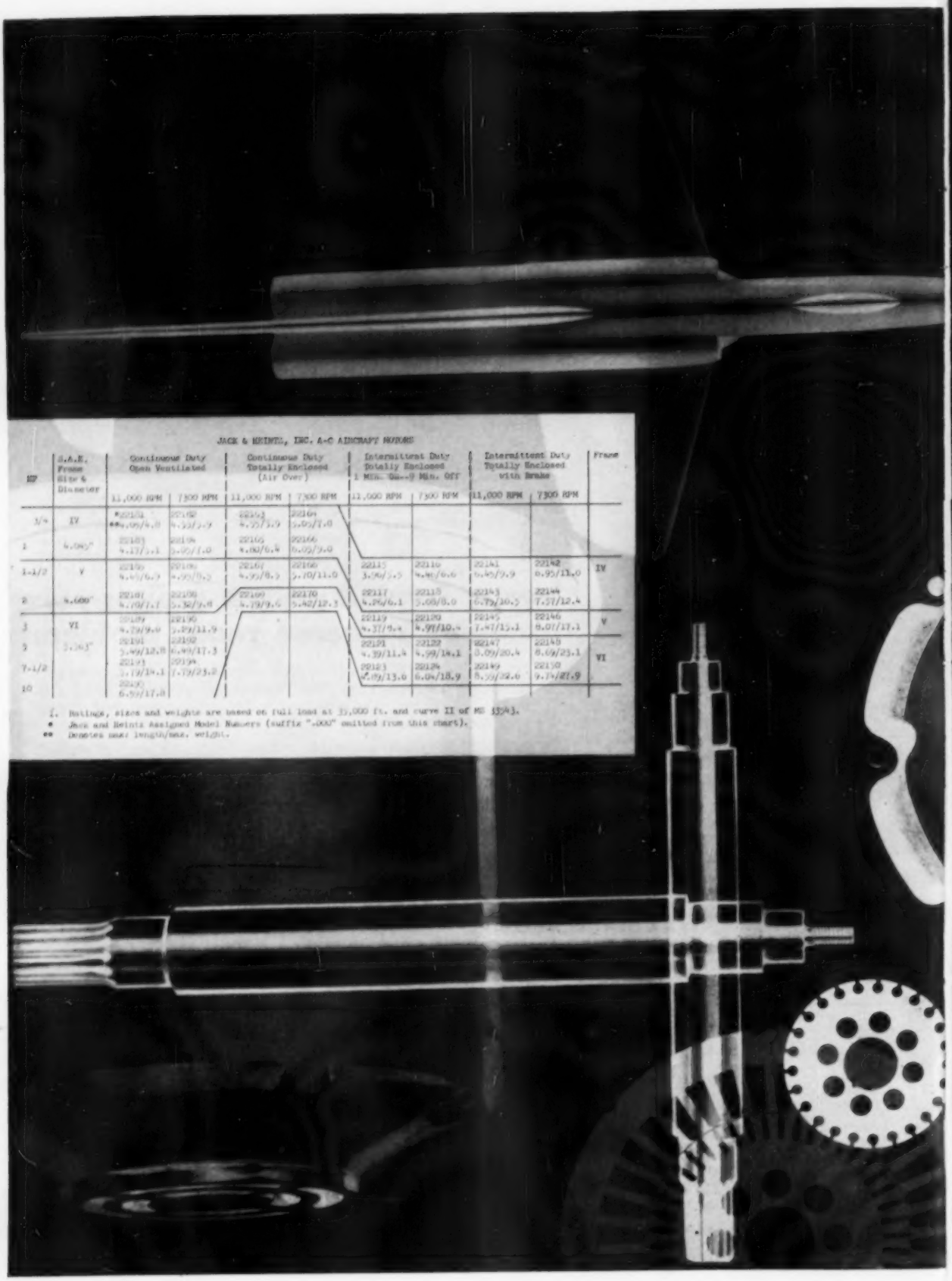

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		11,000 RPM	7300 RPM	11,000 RPM	7300 RPM	11,000 RPM	7300 RPM	11,000 RPM	7300 RPM	
1/4	IV	•22134 ••4.09/4.8	22182 4.33/5.9	22163 4.75/3.9	22164 5.05/7.0					
1	4.060"	22183 4.17/5.1	22184 5.05/7.0	22165 4.80/6.4	22166 6.09/9.0					
1-1/2	V	22185 4.65/6.7	22186 4.93/8.2	22167 4.99/8.2	22168 5.10/11.0	22115 3.80/5.5	22116 4.45/8.6	22141 6.45/9.9	22142 8.95/11.0	IV
2	4.680"	22187 4.78/7.1	22188 5.32/9.6	22169 4.79/9.6	22170 5.42/12.3	22117 4.84/6.1	22118 5.66/8.0	22143 6.72/10.5	22144 7.57/12.4	
3	VI	22189 4.79/9.0	22190 5.29/11.9			22119 4.31/9.4	22120 4.91/10.4	22145 7.47/13.1	22146 8.01/17.1	V
5	5.365"	22191 5.49/12.8	22192 6.49/17.3			22121 4.39/11.4	22122 4.99/14.1	22147 8.09/20.4	22148 8.69/23.1	VI
7-1/2		22193 5.79/14.1	22194 7.79/23.2			22123 4.89/13.6	22124 6.04/18.9	22149 8.59/22.6	22150 9.74/27.9	
10		22195 6.59/17.8								

1. Ratings, sizes and weights are based on full load at 15,000 ft. and curve II of MS 33543.
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ATR Pilot 12,000 hrs. Rated DC4. Some 1049H experience. Desire Airline or Exec. flying or counseling to Business or Insurance Company. Age 46—References. PW-6604, Aviation Week.

Aggressive, dedicated, and competent aviator, college grad., age 27, with 1500 hours Naval Aviation experience looking for an opportunity, not a position, in business flying with responsible collateral business duties. Commercial license, CAA instrument rated. Well rounded education. PW-6645, Aviation Week.

Aircraft Stress Analyst—Nine years experience. Missile work desired on contract basis. Resume on request. PW-6657, Aviation Week.

Airline Captain desires corporation position, airline & military training; 4000 hrs. college, age 33, married. Sales background. PW-6680, Aviation Week.

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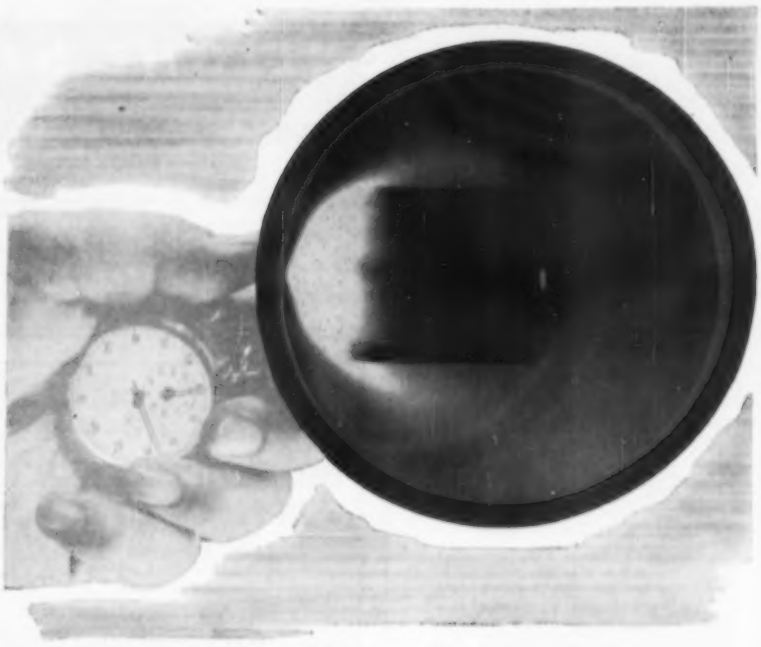

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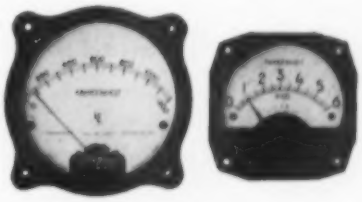

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LETTERS

Editorial Proponents

Congratulations on your forthright thought-commanding and timely editorial "Intelligence Without Leadership," appearing in the Oct. 28 issue of AVIATION WEEK. I sincerely hope it commands the attention it so richly deserves.

I could not agree more re the need for earlier implementation of lessons learned from our fine intelligence efforts.

R. W. RUMMEL
Vice President Engineering
Trans World Airlines, Inc.
Kansas City, Mo.

Just a word of compliment on your well-spoken editorial of Oct. 28 citing the discrepancies between knowledge of what potential enemies are doing and judgment in moving to meet their activities.

In this connection a further problem needs pointing up. Maj. Alexander de Seversky called attention to this in a recent speech before the New York Chapter of the Armed Forces Communication and Electronics Association. He said, "We are building in every direction, trying to be strong everywhere, scattering our scientific and industrial effort over the entire spectrum of weapons, from bayonets to Sputniks."

In this nuclear and supersonic age we must somewhere turn loose of the old gear to afford enough of the new. It is fearsome to contemplate that many millions of dollars are being spent to train young men in such things as the manual of arms and the Revolutionary War practice of holy-stoning the decks of warships when these dollars are needed for the most advanced types of weapons.

Too much of what we are buying seems to be predicated on the need for keeping equal shares of effort in every direction.

JOHN MARSCHALK
Executive Director
Strategic Industries Assn.
Los Angeles, Calif.

I read your recent editorial "Intelligence Without Leadership" (Oct. 28) with much interest after recently reading "Flames in the Sky" by Pierre Closterman (Penguin Books). Mr. Closterman describes the tragic events which occurred at Pearl Harbor and Bataan and the fantastic blunders of leadership and organization.

It is almost impossible to understand what kind of leadership would permit us again to make the same mistakes with their costly consequences. It seems, however, that this very thing is happening according to your editorial.

I think it would be a source of some inspiration and conscience for many who are in responsible positions to read your editorial after reading the description of the heroic defenders of Bataan with obsolete P-40s and P-36s fighting against the overwhelming equipment of the Japanese Navy. It is inconceivable that any man could again risk the responsibility for the slaughter and destruction which was the shame of Pearl Harbor.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address Letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

As political and military leadership in those days apparently left much to be desired it can only be hoped that the leaders of this Western World will take heed of their predecessor's mistakes and the unhappy results.

IAN G. T. HENLEY
Vancouver, B. C.

Your editorial in the Oct. 28 issue of AVIATION WEEK ("Intelligence Without Leadership") was the best yet.

It is sincerely hoped the message received the circulation it deserves and its wisdom accepted. Keep up the good work.

LLOYD L. DRURY
New Orleans, La.

Having been active in aviation for over 25 yr. and having watched the growth of this industry in the U.S. under wavering leadership and in many cases the industry was used as a political football, it is indeed a pleasure to find your editorials in the magazine to be of such fine caliber.

The far-reaching influence that your editorials have is indeed hard to define. Still, the dignity, integrity and obvious overall knowledge of the industry are reflected by your sincere, honest and accurate appraisals of the conditions, and the clear thinking that you show consistently are a definite credit to you personally and a real benefit to the industry as a whole. Whether all your readers are in agreement or not, it is obvious that they must respect your wisdom, understanding and ability to call a spade a spade, and always offer a sound solution to the many complex problems that aviation is confronted with. My congratulations to you and my sincere hope that you keep up the good work editorially and also the fine magazine that you publish.

ROBERT W. BARNES
T/Sgt. USAF
Dover, Del.

Danger of Satellite

The menace embodied in the Russian satellite has not been clearly stated. Consider the following transmutation reactions.

(1) $_{94}Pu^{239} + {}_{-1}e^{0} = {}_{93}Np^{239}$
(2) $_{92}U^{235} + {}_{-1}e^{0} = {}_{91}Pa^{235}$
(3) $_{92}U^{238} + {}_{-1}e^{0} = {}_{91}Pa^{238}$

The stabilization of the nuclei of the product isotopes is indicated by the altered neutron/proton ratio. The product isotopes, $_{93}Np^{239}$ $_{91}Pa^{235}$ $_{91}Pa^{238}$, cannot sustain a chain-fission reaction and, since fission reactions are now used to initiate fusion reactions, the various fusion reactions are also impossible.

These transmutations can be accomplished at long range by utilizing the reaction ${}_{-1}e^{0} + {}_{+1}e^{0} = \gamma$ to create a beam of gamma radiation with suitable characteristics. By subjecting the beam to near-infinite reflection between internal atomic planes of a crystal, the beam can be uniquely polarized to reduce the energy-loss (due to Compton effect) during passage through the atmosphere. Near the nuclei of heavy elements ($A > 200$) the gamma photons undergo the transformation $\gamma = {}_{-1}e^{0} + {}_{+1}e^{0}$. The capture of an electron by a nucleus and the resulting isotope is shown in (1), (2), and (3) above.

By such means the atomic and hydrogen bombs of this nation could be made useless, no more explosive than lumps of iron.

A transmutation beam, as outlined above, could be broadcast from a satellite without difficulty. The weight of the apparatus would be measured in tons, but this mass can be lifted into orbit in small increments with the freighter-stage returning to earth as a hypersonic glider.

Note that the reactions (1), (2), and (3) are reversible. In the case of (1), the neptunium, by beta-decay, is transmitted back to plutonium in about two weeks. However, in the course of events, the transmutation reactions are likely to prove irreversible, for an enemy beam-broadcasting satellite would pass over this country often enough to prevent any accumulation of fissionable isotopes.

A transmutation beam would be relatively harmless to life, but this fact would offer little consolation to a nation stripped of its greatest weapons and standing helpless before its enemies.

This, then, is the threat of the satellite . . . the enemy's ability to bombard the United States with radiation (and particles also, if desired).

ALFRED MACHADO, JR.
New Bedford, Mass.

Moon Satellites

It has been with a great deal of interest that I have followed the articles and editorial comment in my copy of AVIATION WEEK, but there is one item in particular that I would like to bring to your attention for possible comment.

A great deal of interest is presently being placed on the moon—its composition, etc.—and I keep studying the picture of the moon on the cover of the Oct. 28 issue of AVIATION WEEK.

As I look at, it almost becomes third dimensional and the object just about the center of the photograph seems to be floating in space. In fact several of the small objects seem to be disconnected from the surface of the moon.

I am not an astronomy student, but could it be possible that the moon has its own satellites (or meteors) circling it, and occasionally one collides with its surface, giving the moon's surface such a pock-marked appearance?

I know better minds than mine are working on this same subject, so please see fit to do anything with this idea you care to—including the wastebasket.

However, I feel we must all pool our ideas and get our action streamlined so that we can regain our No. 1 place in the moon!

CECIL W. ODELL
Capt. United Air Lines
San Carlos, Calif.

LEACH

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These Leach Relays meet or exceed requirements of MIL-R-5757, MIL-R-6106, MIL-E-5272. Typical ratings include: vibration, 20 G's to 500 cps (higher ratings available); shock and acceleration, more than 50 G's; temperature, −50° to +125°C; life, 50,000 continuous operations minimum at rated load; available 28 vac, 115 vac, 400 cps operation. At right is Leach 9226, 1.49 x 1.49 x 1.68 inches.

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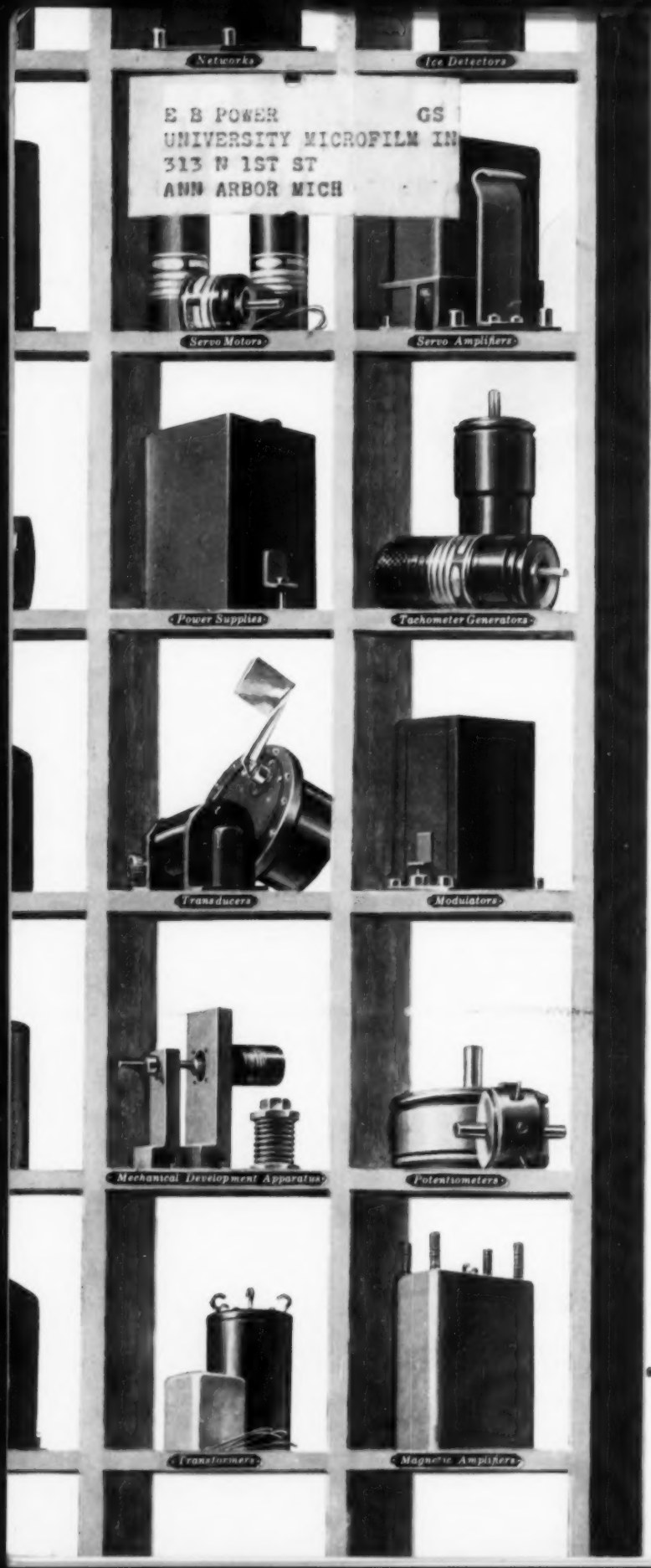

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